5. Brickwork

A. I. A. Standard Classification

Brick

How to Build and Estimate

FOREWORD

IN every building operation, even in the erection of a low-priced house, it is desirable to consult an architect or engineer. In designing and planning; in fitting a building to its environment; in the specification and inspection of materials, the training and experience of a professional man is of value to every builder.

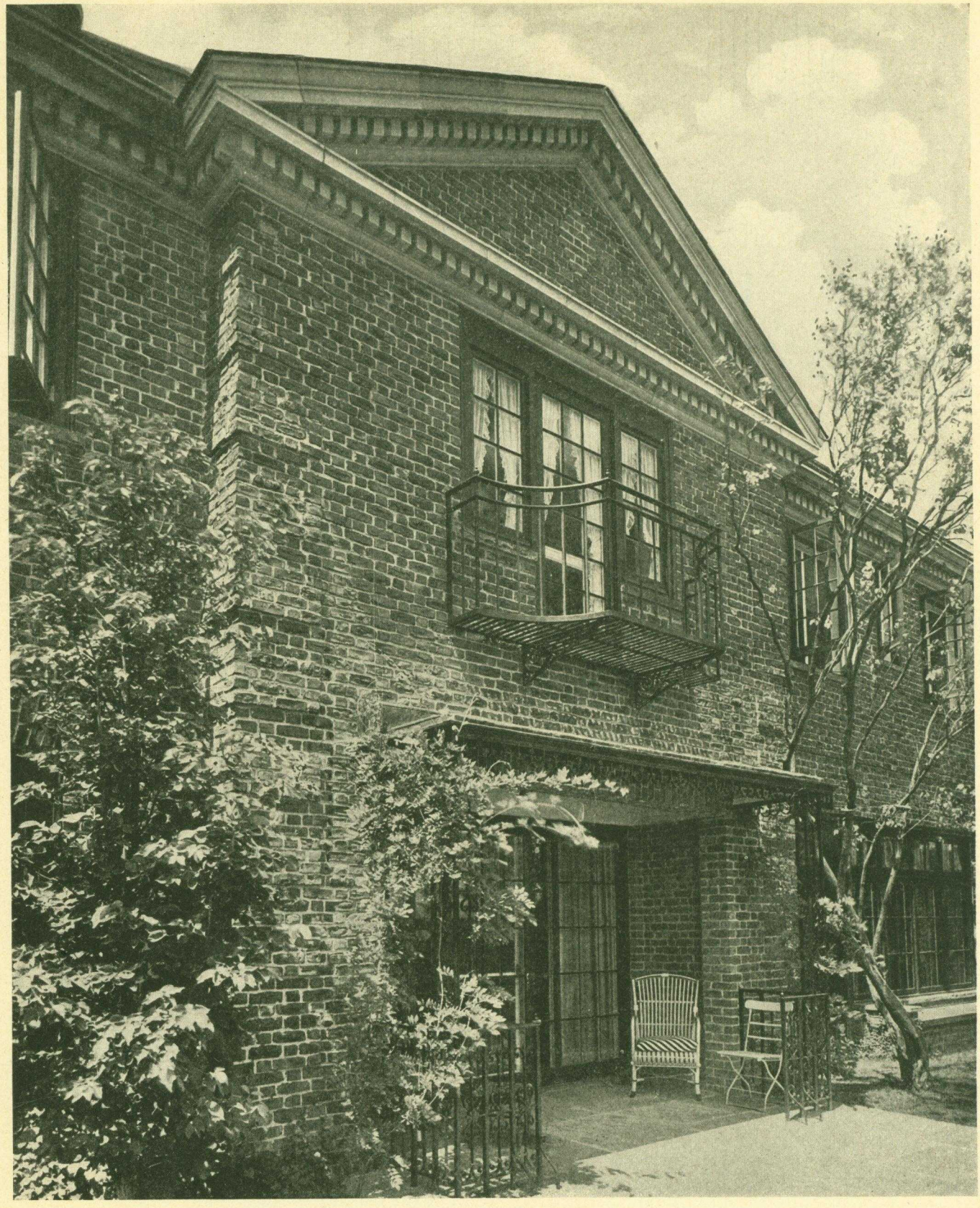
The purpose of this book is to give dependable information upon the use of brick and to afford a basis of co-operation between owner, architect, and contractor in accomplishing first-class results in brick construction.

There unquestionably exists throughout the United States a preference for brick construction. Brick is a native, natural material, and its manufacture is a local enterprise in almost every section of the country. In the erection of apartments, schools, hospitals, store buildings and industrial buildings this preference finds expression in enduring brick structures. In the building of the homes of America, however, brick is not the prevailing material in spite of the national preference for it.

The reason for this is an exaggerated and wholly unfounded belief that the brick home is expensive. The first cost difference between brick and the cheapest form of construction in the home of the average man—a five or six-room cottage or bungalow—in no part of the United States amounts to more than two to four hundred dollars.

Because brick has not been more largely used in residence construction, there is throughout the country a scarcity of mason contractors specializing in home building. A contractor schooled in another type of construction is not usually equipped to give a just estimate upon the cost of the brick home. It is a case of "every man to his trade."

This volume is intended to serve as an aid and a reliable manual of information for the builder who wishes to enlarge his field of operation and meet the growing demand for more substantial buildings. The builder who cannot safely estimate and build in brick will find himself more and more at a disadvantage. The alarming waste of timber and a certain lumber shortage not far away, coupled with a national spirit of conservation which will be expressed in the greater use of more lasting construction materials, is certain to result in increasing the demand for permanent fire-resistive buildings, even down to the most modest priced homes. The architect, builder, the realtor-builder and the contractor may, if he studies this book, find himself better equipped to meet changing conditions.



Courtesy Architectural Record.

Detail of Garden Front —
House at Greenwich, Conn.
John Russell Pope, Architect.

BRICK

HOW TO BUILD AND ESTIMATE

A manual of construction data on brickwork for architects, engineers, contractors and builders; and for class use in educational institutions and manual training schools. A presentation also of some vital facts for prospective owners of houses and other buildings. Of interest to all desiring authoritative information on brickwork and its accessories

BY WILLIAM CARVER
ARCHITECT

FIFTH EDITION—67th THOUSAND
56 ILLUSTRATIONS 9 ARCHITECTURAL PLATES 30 TABLES

The Common Brick Manufacturers' Association of America
Cleveland, Ohio

1924

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BRICK CONSTRUCTION ECONOMICAL AND EVERLASTING

USEFUL MATERIAL HAS MANY ADVANTAGES

Investing in a House:

1. To most people the building or buying of a house is an investment of the first magnitude. Very frequently a man's entire lifelong savings are represented in his home, and in case of sickness or misfortune his ability to raise money will depend entirely upon its selling or loanable value. A man should set about acquiring a house with as much care as he used when he picked his wife.

2. The wise man will ask "Will my investment, represented by my house, yield a fair return? How much will its value decrease, year by year, through wear and tear? What will be the cost of its upkeep? If I ever have to sell it, how much will it be worth? If I ever have to raise money, how much could I borrow on it?" He will also ask "Is it going to be comfortable to live in? What are the chances of it burning up and burning me out?"

3. These are all pertinent questions, and the answer to every one of them depends upon the answer to another question, "Of what material will your house be built"?

Brick and the Pocketbook:

4. Brick has many claims to the attention of every class of prospective builder, and the first and strongest of these claims is **economy.**

5. Though the most distinguished of all the building materials, brick saves dollars and cents to the man who intends to be his own tenant, or who is building as a means of providing an income, or who is a renter; and makes a bigger profit possible for those who build to sell.

Beautiful, Yet Economical:

6. Brick is one of the most beautiful of building materials, and one in which all kinds of architectural designs may be easily conceived and carried out. Those who have traveled in the old world probably remember the charming houses and villages of brick, centuries old, which seem only to grow more mellow under the hand of time.

Ancient Examples:

7. The illustration on the next page shows how brick homes endure. This house, built in England in 1699, in continuous occupation since erected and occupied now, is as substantial, in as good repair and even more beautiful than when built, although it has weathered the storms of over three centuries.

8. Even in this country we may point with satisfaction to landmarks such as Independence Hall, built of brick in 1729 and still in perfect condition. Another brick structure is the little house in which Betsy Ross made the first American flag. Then there is the famous old state house of Boston, Faneuil Hall; the tiny home of William Penn; the many brick inns of the Jersey and Pennsylvania early settlements; the stately and charming old brick houses of Virginia and a host of others too numerous to mention. The men who built these old brick buildings were wise enough to realize, even in their day, the advantages of brick construction.

Brick, the Everlasting Surface:

9. The slogan "Save the surface and you save all," advertised extensively to sell excellent but expensive paint, does not interest the builder in brick. He doesn't have to spend a cent in order to "save the surface." He got an everlasting surface when he bought his brick.

Depreciation:

10. As the years pass, brick does not get that ancient, weatherbeaten look. Age bites at brick vainly.

11. Statistics show that brick buildings depreciate more slowly than any other class of construction. To be exact, a brick house does not depreciate at all during the first five years after it is built, and after that at the rate of only 1% per year. As a comparison frame buildings depreciate 3% per year, beginning as soon as built. These figures are given on the authority of John J. Thomas, of the Lloyd-Thomas Company, Chicago, prominent appraisal engineers; and are taken as a basis of assessment in a great number of cities.

12. Take a typical example,—a brick house costing $6,000 and a frame house costing the same amount. In ten years the frame house will have decreased in value to $4,200; the brick house to $5,700. This is, of course, regardless of the value of the lot and changed values due to other causes.

Brick, the Upkeepless Construction:

13. Consider how microscopical is the rate of depreciation on the ancient buildings to which attention has been called, and remember that their brick walls have required no expense for upkeep, and will require none as long as they last.

14. The upkeep cost of some types—painting and repairs—amounts to approximately 2½% of their cost every year, according to figures published some years ago by the Committee on Fire Prevention of the Boston Chamber of Commerce. In addition to brick walls costing nothing for upkeep, even window frames, being set back from the face of the wall and protected from the weather, do not require frequent painting. $10 a year for painting frames and wood rafter ends on a small brick house is ample.

Figure 2. Whether newly built or centuries old, it is hard to tell the age of a brick house. This house was built in 1699.

15. The upkeep cost on an average $6,000 house at the very conservative figure of $100 per year ($50 below the 2½% quoted,) would in ten years amount to $1,000. Upkeep on a brick house of the same cost would be only $100 for the same period. The ten year period is taken because that is the average time over which payments are spread.

Savings by Using Brick:

16. Summing up the savings so far mentioned:

Saving in upkeep cost.	$ 900
Saving in depreciation.....	1500
Saving each ten years.....	$2400

This total does not include further savings on fire insurance premiums or on fuel.

Cost of Brick:

17. Up to recently there was but one type of burned clay construction that was fire-resistive and permanent,—solid brick. A solid brick home ranges in cost from approximately the same as frame up to $400 or $500 more for an ordinary six room house, according to the locality.

18. A home of Ideal wall construction costs the same or a little less than frame in any locality and preserves all the good qualities of solid brick, while possessing advantages not known to any other construction.

JOHN D. SMALL
CONSULTING ENGINEER
CHICAGO

HEATING & VENTILATING
SANITATION
POWER PLANTS

June 26th, 1919.

To The Common Brick Mfrs. Assn.

Referring to the relative cost of heating a frame house versus a brick house, I have estimated the amount of radiation required to heat a given frame house to be ten per cent greater than the amount of radiation to heat a brick house of the same design and layout of rooms.

The above refers to the primary installation; but there would enter into the matter of heating other factors as time goes on which would tend to increase the cost of heating a frame house over a brick house due to shrinkage of the lumber which would affect the leakage, hence would require, in the course of a few years, possibly five per cent more heating capacity, making at least fifteen per cent more coal consumed than would be in a brick house. I consider this estimate as conservative and trust that this will be of service to you.

From what I have observed in connection with the construction of houses, if I had my choice between a frame and a brick house of the same design and dimensions, I would select the brick house, as in the long run it would represent economy in the matter of heating which would in time go a long way toward offsetting the difference in initial cost of the building; and the heating system would not cost as much as in the case of a frame house.

Yours very truly,

JOHN D. SMALL

Engineer.

A Few Selling Points of the Brick House:

19. With Ideal walls, costs the same or less than any other type.

With solid walls, it costs less than other types by the time all payments are made, counting upkeep cost until that time.

Solid, substantial, enduring appearance.

Attractive at first, grows more beautiful every year.

Walls cost nothing for paint or repair.

Little depreciation.

More fire-safe.

Saves money on fire insurance premiums.

More money can be borrowed to build it.

Take less fuel to heat.

Coolest in summer, warmest in winter.

Has high loan value, should it be necessary to borrow money at any future time.

Retains high sales value for generations.

BRICK, THE MOST ECONOMICAL BASEMENT WALL

Three Types of Basement Wall:

1. Only three types of basement wall material are ever considered in good construction,—brick, stone and concrete. Stone, generally rubble stone, is still used but in decreasing quantity for foundation walls in districts where it is easily obtainable. Concrete has been much exploited for use in basement walls. Intensive sales methods cannot change the basic fact, however, that brick remains the simplest, the most economical, the most impervious, the most quickly erected, the best appearing and the most satisfactory material for such use.

2. It will be recalled that up to a few years ago brick was the prevailing material used for foundation walls, and that such walls gave, and still give, universal satisfaction.

Brick Cuts Down "Overhead":

3. The remarkable simplicity of brickwork commends it to every contractor who realizes the great advantage of having one set of mechanics begin and completely finish a wall at one operation, using the very simplest equipment. With brick there is also the least chance for unexpected items of expense. The integrity and appearance of brickwork is a known quantity before it is built. Brick safeguards the contractor's profits.

Little Equipment Is Needed for Brick Basement Walls:

4. A mortar box, mortar boards, a sand screen and a few trestles—that's about all that is needed for brick work equipment. For chimneys and independent piers trestles and scaffold plank will be required, but joists for the upper stories can often be used for the latter. The lower part of the exterior wall is generally built from the excavation, the upper part from the grade.

5. Brick construction eliminates the expense and trouble of building elaborate runways, purchasing high priced equipment and falsework, moving it around, repairing and overhauling it and storing it between jobs. Machinery and equipment depreciate and become troublesome. Build all the walls of brick and don't tie up extra money in equipment. Use it to finance another job.

Brick Basements Require Less Excavation:

6. When building a brick foundation wall the excavation need be but slightly larger than the house itself.

Build With Brick and Keep the Basement Clear:

7. Note in Fig. 3 how clean and free from obstructions the brick basement is. Brick construction proprovides a basement with full working space. No

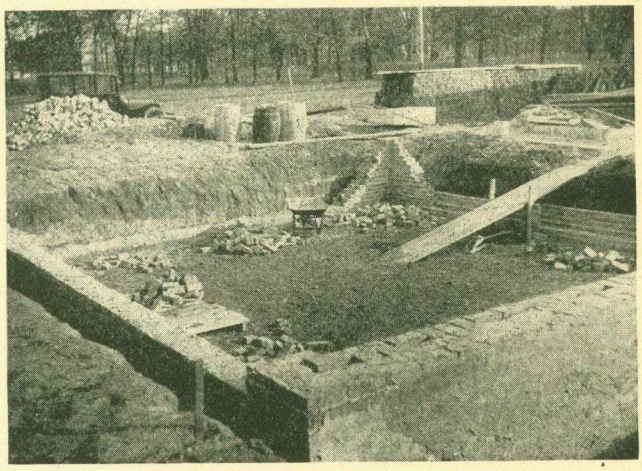


Figure 3. Note the small amount of equipment needed and the simplicity of building a brick basement.

material is carried into the basement except that which is actually placed in the walls. Consequently none has to be carried out afterwards. Brick eliminates expensive mess and expensive bother.

Brick Foundations Save Time:

8. As soon as the excavation is finished the bricklayers start and do not have to wait for any other trades.

Brick Eliminates Much Supervision:

9. One bricklayer and a laborer can build the brick basement walls of a home in a few days. By eliminating many operations, brick eliminates also the supervision of men required to perform them. The more men on a job the more it costs to "hire and fire" them or to move them from one job to another, and to keep track of their time. Brick reduces the number of men to the minimum and saves personal time and worry for the contractor.

Brick Walls Have Great Stability:

10. Owing to its enormous factor of safety and the thorough bonding of all the brick units, the brick wall will easily resist considerable unexpected thrust and stresses.

Brick Basements Moisture Resistive:

11. Well burned brick are much harder, more impervious and have less absorption than ordinary concrete or concrete blocks. The material in the mortar joints is of the same general nature as concrete, except that it is richer, but with brick the mortar joints form only a fraction of the area of the wall and the less mortar or concrete exposed, the less danger of penetration of moisture.

12. It is much safer and better construction, however, to properly damp-proof or waterproof any basement wall, of whatever material constructed; and the logical place for such water or damp-proofing is the exposed side. Placed in this position it prevents the penetration of moisture into any portion of the wall itself. The character of the water-proofing should be proportionate to the degree of dampness in the soil. (Pars. 27-34, page 54.)

13. Condensation forms less easily on a brick surface than on a wall surface of other materials.

Brick Basements Unaffected by Alkali:

14. In localities having alkali in the soil, only brick should be even considered, some other materials having a tendency to soften and disintegrate in such places.

Brick Basements Have Greater Sales Value:

15. The brick wall presents no imperfections of surface, no unsightly bulges or patched up portions. The rich coloring of well laid brickwork gives distinction to any wall built of it, whether it be the foundation only, viewed from the outs de or inside, or whether the wall extends entirely to the roof.

16. A brick basement will help to get a good price for the house, for the buying public appreciates a good looking basement. Should it be desired to afterward finish a basement room as a children's play room, billiard room, or for any other purpose, remember that the brick surface is unexcelled as a rich background for pictures, rugs, wrought iron ornament or other decoration.

BRICK, EASY TO USE; GIVES INCOMPARABLE RESULTS

(See also page 24, pars. 4 to 17 and pages 26 and 27, pars. 6 to 20.)

Convenience of Brick:

1. Quite apart from considerations as to which material gives the best service to the owner, contractors find it to their own interest to use brick in preference to any other material.

2. The contractor is interested primarily in getting the building up and off his hands as quickly as possible, consistent with the time required to make a good job. Brick is the one material which can almost always be obtained locally without delay and rail transportation expense.

3. Brick can be stored in any kind of weather without deterioration. Brick does not check, warp or split and does not spoil when wet. Wetting, in fact, saves labor, for brick should be laid while wet.

Little Waste With Brick:

4. The ordinary brick supplied to a job are generally handled in the cheapest possible way. They are dumped from wagons with but little breakage and every bat can be used as backing or filling in. Contractors know that some other material must be handled carefully to prevent loss or breakage and even then the percentage of waste is high.

No Special Sizes and Shapes of Brick:

5. Brick is an extremely flexible material, because of the small and standard size of its units. Special sizes and shapes for corners, jambs and other locations are not required. This simplifies ordering, storing and using material. There is no possibility of losing time and money by having to wait for or sort out special sizes for special locations.

Little Chance for Weak Spots:

6. Every portion of every cubic foot of brick is constructed of material having a very high factor of safety; and is laid by, and comes under the personal scrutiny of a high grade mechanic. The chance of a brick wall or pier containing weak spots is remote. It will always carry the load it is designed to bear. (See test results on a poorly laid pier, Table 13, page 32.) The strength of brickwork does not depend on any speculative operation.

Brick Resists Heat and Cold, and is Always Dry:

7. The best insulation against heat, cold and dampness is provided by the wall of brick. Everyone knows how cool the inside of a brick building is on a hot day. In winter it keeps in the heat just as efficiently as it keeps the house cool in summer.

8. The solid brick wall furred, or the Ideal wall unfurred is always dry. It is proof against dampness coming from the outside, and condensation from within.

Alterations Easy With Brick Walls:

9. If an addition is to be made, a new wall, pier, or flue can easily be joined to an old one at any point.

10. New openings can easily and quickly be made, and every brick taken out can be used over again, no matter how long the wall has been standing. The enormous strength of the brick wall makes the safe cutting of even wide openings perfectly feasible under most conditions. Cutting new openings throws more load on the parts of the wall that are left. The brick wall has great reserve strength to carry these extra loads. Because of the small size of the brick units, openings can be cut to the exact dimensions desired. (Page 27, pars. 18-20.)

Brick Bearing Surfaces:

11. One of the most important functions of a wall is to support the floors and the roof. A brick wall of either solid or Ideal construction forms a splendid solid bearing surface. The wall being built of small bonded units, the load is quickly transmitted over a large area.

Brick Has High Salvage Value:

12. The brick wall successfully resists the action of fire and a brick wall does not have to be rebuilt

when the burned structure is restored, unless the wall has been thrown down by mechanical forces, such as falling beams. It is those advantages that secure to the brick building favorable insurance rates.

13. Be sure, therefore, that all the bearing members in your building rest upon brick, for these are really fire-resistive. Run the brick right up to the roof.

Brick Piers Are Permanent:

14. Always use brick piers in the basement for supporting beams. Brick is not affected by dampness, never shrinks and never rots.

Brick Piers Cost Less and Are Superior to Metal Stanchions:

15. Brick piers are less expensive and more convenient than metal stanchions. With the latter, the level of the footing must be figured to the fraction of an inch or the top will not line with the soffit of the beam. Both the stanchion and the beam also require bracing and wasted labor until the floor joists are placed. The base of the stanchion, being small, must have a footing strong enough to spread the concentrated load. The brick pier is rigid and stable as soon as built and of course requires no bracing; courses can be adjusted to come to any exact height; and the pier is fire resistive.

16. Stanchions are likely to rust, and either with or without concrete filling, cannot be classed as fire-resistive. Filled with concrete and reinforced in the fill, with structural steel shapes, reinforced steel pipe are given only ¾ hr. fire rating. Filled with plain concrete, they are given only 25 min. fire rating.*

17. Records show that many fires start in the basement; therefore make every pier and partition in the basement of brick. An all-brick basement helps to sell the house.

Brick Paving:

18. In localities where brick is of a hard quality, it may be used to pave the basement floor. Such a pavement adds greatly to the appearance of any basement. Ask the brick manufacturer in your district whether his brick will give good service when used for this purpose.

Brick Facing for Kitchen Walls:

19. The kitchen wall always has a great deal of hard wear and should have a surface that cannot be disfigured. The walls of kitchens in houses of the better class are sometimes laid with brick exposed up to the height of the doors. A projecting course of brick, or a small wood mould, is run around the room at this height, the wall above being plastered.

20. This treatment is a little more expensive than a plastered wall but looks much neater. It has a surface that stains, grease or smoke will not disfigure.

21. If brick are laid flat, this treatment involves the construction of 4" brick partitions under other than outside walls, forming a small room in the basement, the same size as the kitchen above. This room can be used as a cool storage room for vegetables or for many other purposes. If brick are on edge the weight can, in some cases, be carried on the wood floor construction; the brickwork being attached to the studs by tenpenny nails driven in the studs at the level of the joints.

22. Even if the kitchen walls are plastered always allow the brick behind the range to "show."

23. If a painted surface is preferred, the brickwork can be sized and enameled or painted white or any color desired.

Roofs:

24. We strongly urge the use of only fire resistive materials for the roof of any home, for unless protected by a fire resistive covering, the roof forms a vulnerable spot against adjacent fires. Fires are often communicated from one house to another by flying sparks setting fire to shingle roofs. Fire prevention experts pronounce the wooden shingle one of the prime causes of conflagrations.

25. The most beautiful and most fire-resistive roof covering is that of burned clay tile and next in order comes slate. Concrete tile are also fire-resistive. but their coloring does not stand strong sunlight, Asbestos shingles are fire resistive and asphalt shingles do not spread fire.

Protection at Hazardous Places:

26. In view of the many fires which start in basements we suggest that in addition to building an all brick basement with no wood or iron posts or wood partitions, the wood joists at the ceiling be protected by some fire resistive material. Plaster on metal lath or gypsum board is excellent for this purpose; also under and at side of all stairways; in closets and many other hazardous places around the house.

*Fire Tests of Building Columns. See page 32.

TABLE 1.
Average Weight of Solid Brick Walls.
Brick Assumed to Weigh 4½ lb. each. ½" Joints Filled with Mortar

Area in Sq. Ft.	4-in. Wall	8-in. Wall	12-in. Wall
1	36.782 lb.	78.808 lb.	115.414 lb.
10	368	788	1 154
20	736	1 576	2 308
30	1 103	2 364	3 462
40	1 471	3 152	4 617
50	1 839	3 940	5 771
60	2 207	4 728	6 925
70	2 575	5 517	8 079
80	2 943	6 305	9 233
90	3 310	7 093	10 387
100	3 678	7 881	11 541
200	7 356	15 762	23 083
300	11 035	23 642	34 624
400	14 713	31 523	46 166
500	18 391	39 404	57 707
600	22 069	47 285	69 249
700	25 747	55 166	80 790
800	29 426	63 046	92 331
900	33 104	70 927	103 873
1000	36 782	78 808	115 414
2000	73 563	157 616	230 828
3000	110 346	236 424	346 243
4000	147 128	315 232	461 657
5000	183 910	394 040	577 071
6000	220 692	472 848	692 485
7000	257 474	551 656	807 899
8000	294 256	630 464	923 314
9000	331 037	709 272	1 038 728
10000	367 819	788 080	1 154 142

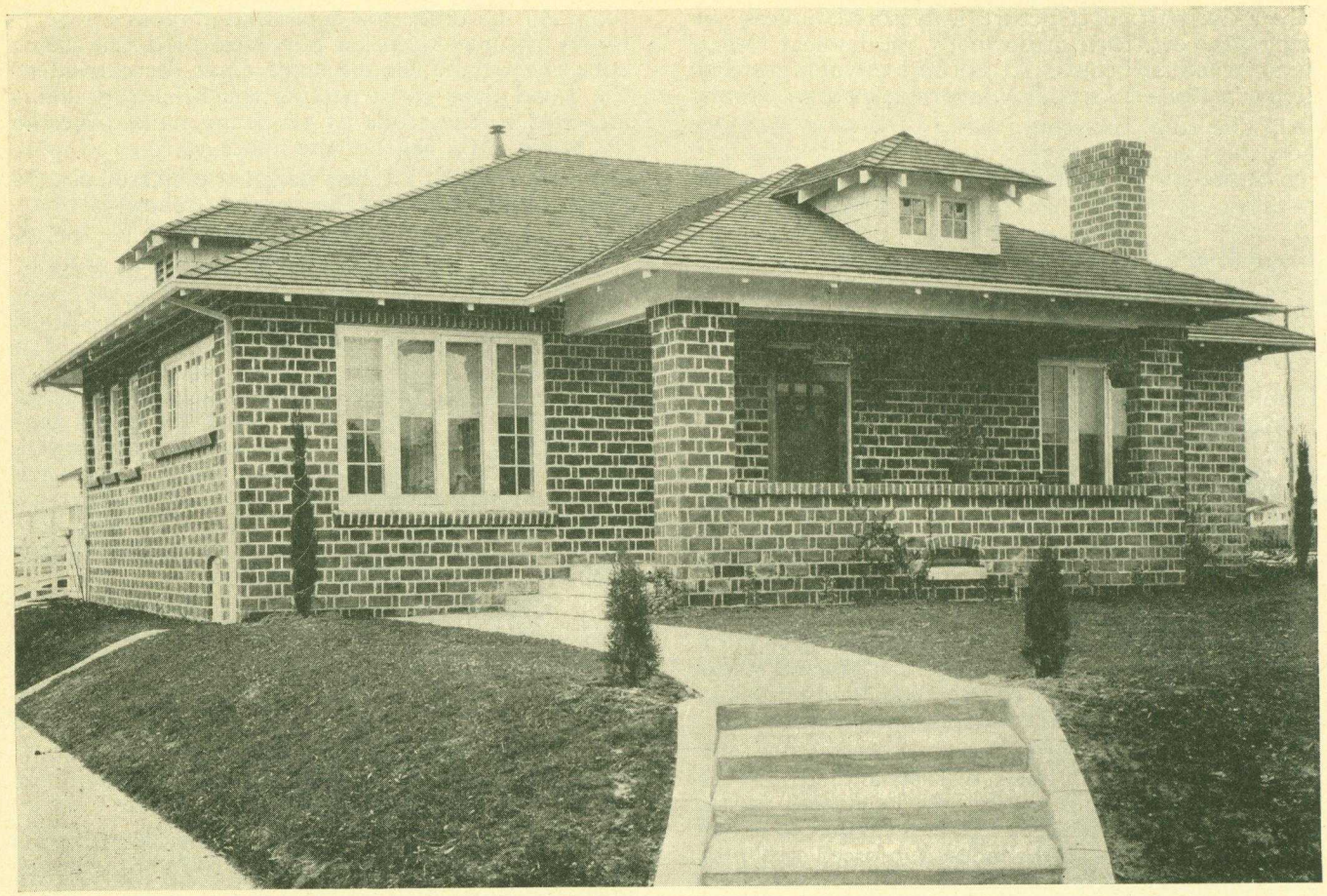


Figure 4. Comfortable, "homey" Ideal wall bungalow.

THE IDEAL WALL
THE LOWEST COST EVERLASTING CONSTRUCTION

1. This is the name given to a new type of brickwork. Using standard brick, this new development produces a substantial and well insulated wall of any thickness from 8 inches up, at less cost than any other type of construction.

2. The Ideal wall has the great advantage of a considerable saving in both materials and labor, combining the advantages of the solid brick and hollow unit types of wall at a lower cost than either.

Two Types of Ideal Wall:

3. In the Ideal all-rolok wall all the brick are laid on edge.

4. In the Ideal rolok-bak wall the brick in the outer 4 in. course are laid on their flat bed, so that the wall has the usual brick appearance; the backing brick being on edge. Header courses may be run at every third or every sixth course and any bond may be used.

5. With the Ideal rolok-bak wall, each header which extends from the flat outer course to the backing of brick on edge must have a small filling piece placed over it to make the brick on edge course line on top.

6. It is not necessary for the bricklayer to cut a special piece for this filler. Brick chips lying on the scaffold can be used for this purpose; well slushed with mortar.

Interruption of Mortar Joint:

7. Examination of the plates will show that the Ideal wall has an absolute, positive break in the mortar joint in the direction of the thickness of the wall; thus accomplishing with ordinary brick what has long been striven for in vain through the use of special shapes and units which lack many of the good qualities of brick and are not so convenient to use.

8. In a wall above grade it is almost impossible under conditions existing in actual practice, for a well burned header to carry moisture along its entire length by capillary attraction. Moisture can, under severe conditions, be conducted along a mortar joint either of cement or lime mortar; hence the importance of interrupting the joint.

9. The 8-inch Ideal wall has one break in the mortar joint and the 12-inch wall has two.

Ventilated Air Space:

10. To further safeguard the inside surface, a slight steady circulation of air in the cavity dries out any small amount of moisture that might reach the portion of the header within the hollow space.

11. The 8-inch wall has one ventilated space, the 12-inch wall has two.

No Material in Direct Contact Through 12-inch Wall:

12. The plates distinctly illustrate this point—a well bonded wall with no material in direct contact from front to back. No equal to this wall has as yet been devised for weather resistive qualities.

Brick for the Ideal Wall:

13. No special sizes or shapes of brick are required for the Ideal wall. Standard size brick only—2¼″x 3¾″x8″—either face or common, are used.

14. Greater speed of construction is possible when a non-impervious brick is used for Ideal wall construction. The use of shale or similar hard impervious brick slows down the work where the brick are laid on edge. The use of non-impervious brick is also advisable for the reason that such brick make the most weather resistive wall in Ideal construction. It will readily be seen that during a very heavy and long continued downpour of driving rain an absolutely impervious header might conduct a slight amount of moisture along its surface toward the inner face of the wall, whereas a header of non-impervious brick would absorb this moisture, which would be dried out by the slight steady circulation of air within the hollow space.

Omission of Furring:

15. From many parts of the United States users report that plaster applied directly to the inside brick surface of properly built Ideal walls—without the use of furring—has proved satisfactory, and that with walls so constructed buildings are warm, dry and comfortable. With any kind of construction there are, of course, factors beyond the control of the material manufacturer and which affect the properties of the finished structure. Supplementing the brick, there must be also reasonably good mortar and workmanship, and where such are used it is the belief of

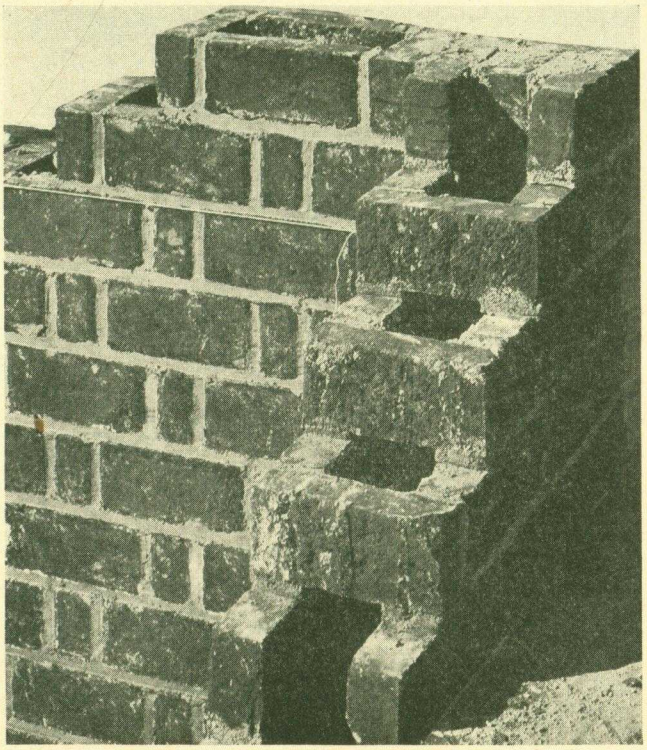


Figure 5. Note the sturdy construction of the all-rolok wall, with its 2¼ inch webs and ventilated air space.

Figure 6. Built in 1880 at Arhultemala, Sweden, this Ideal wall bungalow (plastered directly on the brick) has proved comfortable through the summers and severe winters of that northern climate.
Courtesy Brick and Clay Record.

the author, based on a remarkable record of satisfactory performance, that furring may be safely omitted with the 8″ Ideal wall and the plaster applied directly to the inside brick surface; excepting in those parts of the United States which have long continued periods of severely cold weather, such as Northern Michigan, the Dakotas, and Montana, in which localities the 8″ wall should be furred or the 12″ unfurred Ideal wall used instead. The brick in all cases should be selected as recommended in pars. 13 and 14 above.*

Ideal Construction, for What Use Adapted:

16. Ideal construction is adapted for the following uses:

(a) Foundations and walls of the superstructure of all residences.
(b) Load bearing walls wherever the hollow unit type of wall is now employed or allowed.
(c) Spandrel, curtain and partition walls.

17. For fire, division, and party walls only solid brickwork should be considered, according to the best engineering practice.

Experience Proves Ideal Wall Satisfactory:

18. Although this method of laying brick was developed by The Common Brick Manufacturers' Association of America there have been found numerous examples of this construction in various parts of the country and in Europe. A bricklayer or a contractor here and there has hit upon this idea and used it in one or more structures, but never before

*A practical test to determine the degree of imperviousness of the Ideal wall was made at Williamson Trade School, Delaware County, Penna., under the direction of Prof. Joseph Shisler, Instructor in Charge of the Masonry Department, who is also the author of the following report:

Apparatus—One adjustable nozzle, length of hose, clamps and supports.
Wall—8″ thick laid in Flemish bond all bricks on edge (Ideal wall).
Mortar—1 part lime paste, 3 parts clean bar sand.
Joints—⅜″ thick concaved with round steel jointer.
Bricks—Common straight hard, end wire cut.

Conditions—Wall built in shop on cement floor. Inside surface plastered ⅜″ thick with 1-3 lime and sand mortar and finished with ⅛″ hard white coat of calcined plaster and lime paste. This surface after four (4) weeks drying was papered with common wall paper.

Method of Testing—The hose with nozzle attached was connected to faucet and water was turned on so as to produce a continuous running sheet of water on surface of brickwork. Measure showed 25 gal. per hour per square foot of wall surface.

This proportion was reduced to a smaller area for closer observation involving only a few bricks under severest test conditions.

Result—After 3 days (72 hrs.) it was found that the bricks in the most saturated portion of the wall had not transmitted sufficient water through wall to even dampen wall paper on interior.

The stretchers on outside face of wall were wet on back surface but the headers which extended through the wall to the plaster had conducted the water only one half this length.

The plaster on inside face of wall after being removed showed no evidence of moisture.

Conclusion—The purpose of the test was to determine whether the elimination of furring and lathing is practical when cheap bricks are used for hollow wall. Since the test was more severe than natural weather conditions and that the poorest grade of outside brick was used the evidence was convincingly favorable toward the hollow wall, non-furring construction.

Also when compared with a hollow tile wall 8½″ thick each foot of this wall had 34 square inches more bearing surface than hollow tile.

has it been worked out in all its details to fit varying conditions nor was it promoted until recently. The Association has carefully investigated every example of this construction that has been brought to its attention. Although some of these buildings have been standing fifty years they have, without exception, given satisfaction and proved substantial and durable.*

19. Mr. Gust. Bern, director of the Swedish Brickmakers' School of Experimental Brickwork, Svedala, Sweden, states that his father built the cottage shown in Fig. 6 of one thickness of hard burned brick, plastered without furring. The Swedish winters are very long and severe (22 deg. F. below zero being not unusual); but the house has always proved dry and comfortable.

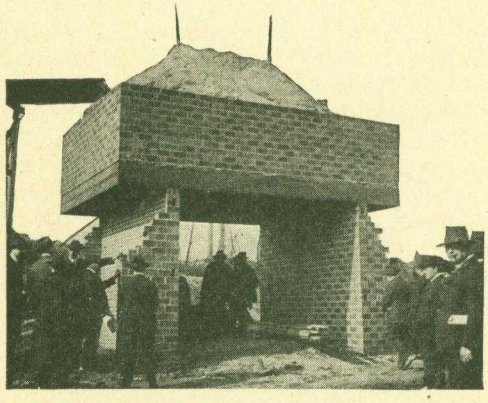


Figure 7. Eight inch Ideal wall test structure designed by Virgil D. Allen, formerly Building Commissioner of Cleveland, and built for the inspection of the Building Officials Conference, held in Cleveland, 1921. Sand box, sand and walls weigh 82 tons, or 6,750 lbs. per ft. run at base of walls. No sign of distress observed.

20. Investigations and tests made by the Common Brick Manufacturers' Association indicate that the strength of the Ideal all-rolok wall may be fully equal to that of a solid wall of equal thickness.

21. The strength of the Ideal rolok-bak wall, while less than that of the all-rolok wall, closely approaches the strength of the solid wall also.

22. This result is due to the fact that the transverse or bending strength of a brick laid on edge is greater than its transverse strength laid flat; a brick when laid in a wall having to resist stresses similar to those in a beam, in consequence of slight inequalities in the supporting bed and superimposed bed of mortar. (Pages 29-30, pars. 22-27.)

23. It is to be noted that the thinnest web in any Ideal wall has a 2¼" thickness of solid material. The manner of laying the units makes it impossible to have the webs out of vertical alignment. (Fig. 5.)

Fire Resistiveness:

24. It is the belief of the author that the Ideal wall retains much of the fire resistive properties of the solid wall. The webs and cross webs of Ideal walls, being formed of solid units separated by mortar joints, can expand without rupturing the units of which the wall is built.

U. S. Bureau of Standards Tests:

25. At the time of the publication of this book the U. S. Bureau of Standards was engaged in making tests to determine the exact compressive and fire-resistive values of all types of Ideal walls. Inasmuch as a number of tests must be made upon any type of masonry before safe working averages can be determined, the making of these tests and the issuing of a report will take some time. A preliminary statement is, however, now issued by the Bureau and is obtainable by addressing a request to the United States Bureau of Standards, Washington, D. C.

Ideal All-Rolok Wall, Appearance:

26. The Ideal all-rolok wall is laid in Flemish bond. With any brick it has a surprisingly distinctive and attractive appearance. When the rough or wire cut surface of the stretchers is exposed in combination with the smooth end of the headers this produces an effective and charming appearance. (Fig. 8.) Before passing on the appearance of the Ideal all-rolok wall, lay up half a dozen courses or inspect a sample wall. Whenever judgment is based upon a sample or an actual wall there is no further question as to its beauty.

Ideal Wall, Simplicity:

27. The Ideal wall is a finished wall, requiring no further treatment—no stucco outside. For summer cottages, etc., even the interior plastering may be omitted. It thus eliminates several operations and lessens overhead expense for the contractor.

Ideal Walls, Cost:

28. The Ideal all-rolok wall is the lowest in cost of any type of wall construction, wood or masonry. The Ideal rolok-bak wall costs a little more than the Ideal all-rolok, but is below any other type of masonry construction.

29. Allowing for ½" joints, one hundred square feet of the several types of wall listed requires the material listed in table 2, page 14.

Brick Laid Per Day:†

30. Although, on the average, fewer brick may be laid per day with Ideal than with solid walls, a

*The Structural Service Bureau, Philadelphia, reporting on a group of Ideal wall houses at Phillipsburg, N. J. states: "Mr. Paul R. Smith (the architect) states that the 8" Ideal wall is a great success and in a short time will come into general use. He states that although the walls are not furred there had been no moisture show through on the inside of any of the houses, whose ages ran from several months to one year. In conversation with the people living in these houses and in response to definite questions there was no complaint of moisture or air leakage; in fact all appeared well satisfied with their occupancy of these houses. We conclude the eight-inch Ideal wall house is very satisfactory throughout this development."

Similar favorable reports on the behavior of this wall during the rainy season come from California; and other sections of the country report the success of Ideal walls wherever erected.

†The Richards Brick Company, Edwardsville, Ill. makes the following report on the cost of laying Ideal walls in a 6-room brick bungalow 32 ft. by 30 ft. exclusive of front and rear porches; the first Ideal wall house built in that district. House built in spring of 1921. Bricklayers were unfamiliar with Ideal construction.

Exterior basement walls to grade—solid walls.

Interior basement partitions—8" Ideal all-rolok walls. (These were badly cut up by openings and corners.)

Walls above grade—8" Ideal rolok-bak walls faced with face brick.

Number of face brick used	15,200
Number of common brick used	26,000
Total brick used on job	41,200
Total bricklayers' time for entire job	260 hours
Total laborers' time for entire job	240 hours

Average number of brick laid by each mason per 8-hour day on entire job 1268.

This includes chimneys, piers, porch walls and all brickwork.

With bricklayers' wages $1.25 per hour, laborers' $.85 per hour, total cost of masonry labor on entire house was $529.00 or $12.84 per thousand brick.

The following number of brick were laid in interior basement partitions (8" Ideal all-rolok walls with plain cut joints, requiring 3203 brick): Each mason per 8-hour day laid 1349 brick. This averages 81 more brick per day than average for entire job.

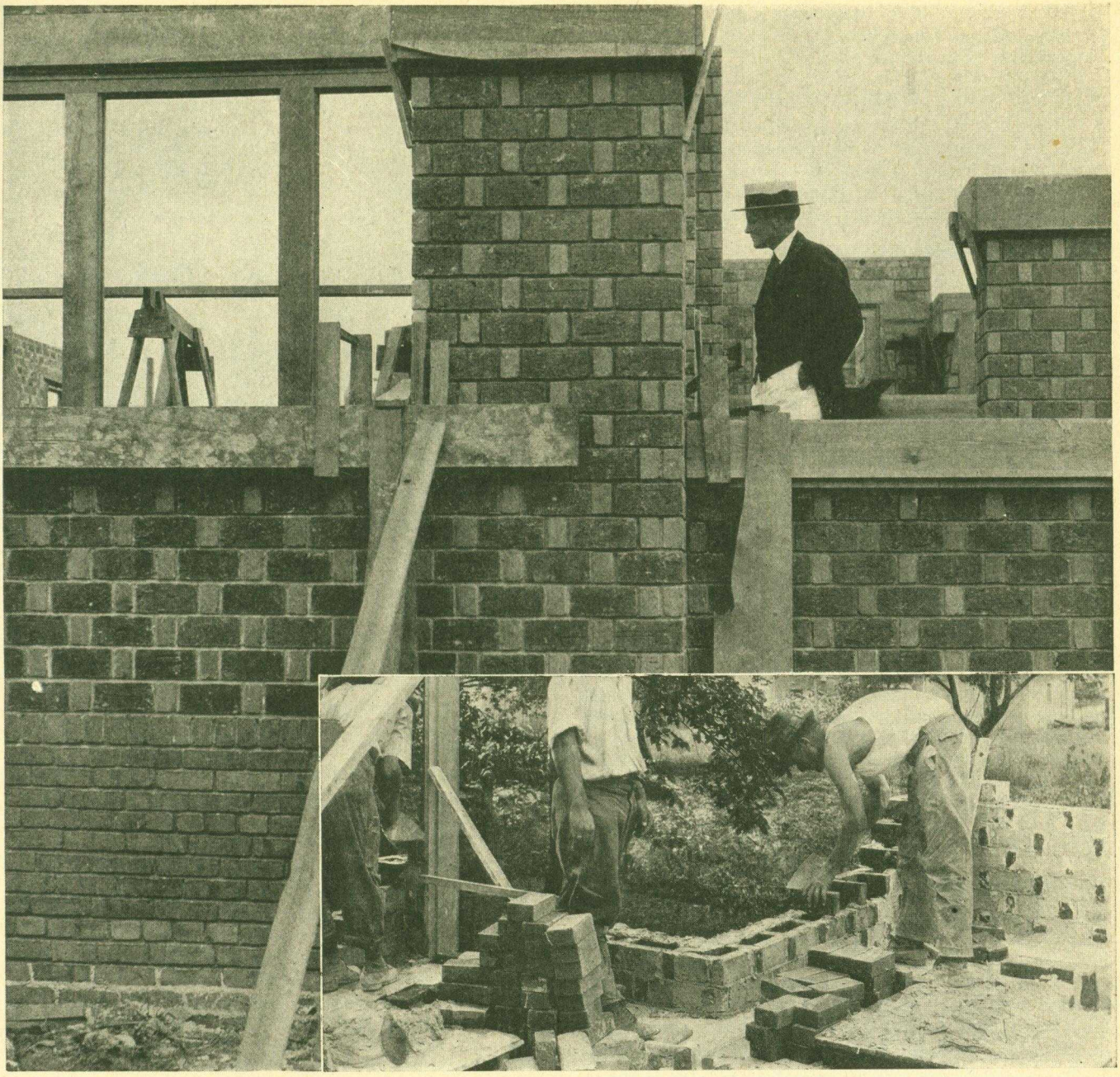


Figure 8. Ideal walls under construction. Note pleasing appearance of rough or wire cut surface of stretchers in combination with smooth headers.

greater area of wall is laid per day. In some cases, however, bricklayers experienced with this construction approach closely the number of brick laid in solid work. In sections where Ideal construction is much used, labor contracts have been taken to lay Ideal walls for $12 per M brick, this price including bricklayers' and laborers' time and profit on the contract.

Thickness of Ideal Walls:

31. Local ordinances govern permitted wall thicknesses in various localities. In their absence the following safe minimum thicknesses may be followed.

32. Above the first floor line the 8″ wall is recommended for enclosing walls of two and one-half story residences, residential buildings (such as apartments or club buildings,) or other buildings having similar light floor loads and in which story heights and unsupported lengths of wall are not excessive.

33. For three story buildings similar to those described above, the first story should have a 12½″ wall and an 8″ wall above and for four stories the first and second story walls should be 12½″, and 8″ above.

34. For resisting earth pressure, basement walls for residences, whether the superstructure is brick, frame, or any other material, should ordinarily be 12½″ thick.

35. Where the basement is shallow, or the soil dry and gravelly or of such consistency that earth pressure will not be excessive, basement walls for residences up to two and one-half stories high may, under favorable conditions, be built eight inches thick if of brick.

36. A 12½" Ideal basement wall is sufficiently strong under ordinary conditions for buildings classified above, four stories high.

Flexibility in Thickness of 12½ inch Wall:

37. It will be noted that the exact thickness of the 12½ in. wall may be varied considerably to suit any special condition. It may be made from 11¼ in. to 13¾ in. thick without changing the quantity of brick, mortar, or labor required to build it.

Ideal Walls Dry Out Quickly:

38. Because of the slight current of air in the cavities, the Ideal wall of any thickness dries out very quickly, the mortar soon attaining its maximum hardness. The full load can be placed upon it soon after it is built.

39. The slight current of air around the ends of the joists helps to prevent dry rot.

Ideal Walls Bond Naturally Into Solid Walls or Piers:

40. Where piers or sections of solid wall are deemed necessary to support specially heavy loads, Ideal walls can easily be bonded into them. Moreover, solid brickwork is built of exactly the same materials as Ideal walls, so that no special material need be taken on the scaffold.

41. Attention is specially drawn, however, to the great increase in strength and the economy made possible by laying up walls or piers of brick on edge, the piers being made either hollow or solid, according to the load to be supported. The courses of Ideal walls, of course, coincide with courses of solid walls and either hollow or solid piers so laid. (Pars. 22-27, pages 29-30.) Short sections of brick on edge wall laid solid may sometimes support concentrated loads, eliminating projecting pilasters.

No Difficulties in Bonding Brick Webs:

42. Where face bricks are tied into backing of special material of special shapes and sizes, difficulty is often encountered in making the courses coincide where the headers occur, making it necessary to split courses or adopt the unsatisfactory device of tying with metal ties. All trouble of this kind is eliminated in the Ideal wall, particularly in the all-rolok type.

43. Where face bricks are used outside, Ideal backing has the further advantage of being thoroughly bonded to the face, thus adding the strength of the face brick to the strength of the wall.

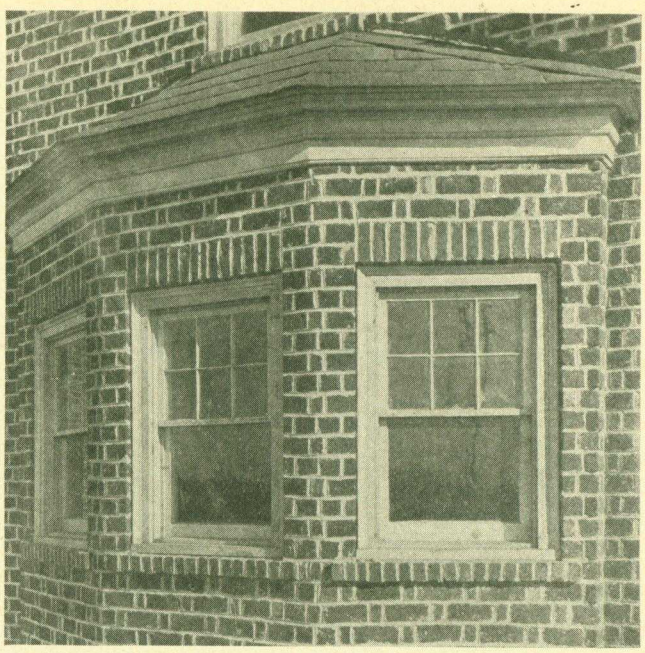


Figure 9. Bay windows or other ornamental features present no special difficulty in Ideal construction.

Use of Bats:

44. The usual proportion of bats may be used in the Ideal wall. An occasional stretcher on edge in the backing may be replaced by three small bats, by a three-quarter brick and a small bat, or by two bats half a brick long. In the 12½-inch all-rolok wall shown on Plate No. 2 the bats or three-quarter brick may be placed entirely on the inside web; and the inside and outside face built entirely of whole bricks.

Use of Soft or Salmon Brick:

45. It is an advantage to use soft or salmon brick for backing, such brick not only costing less, but affording an unexcelled bonding surface on which to plaster. Walls with a salmon brick backing have more than ample strength for ordinary purposes. (See tests on individual soft and underburned brick, Table 6, page 29, and of piers of underburned brick, Table 13, page 32.)

Bond of Ideal All-Rolok Wall:

46. In the 8-in. Ideal all-rolok wall (Plate 1) and the 12½-in. Ideal all-rolok wall (Plate 2) the wall is bonded entirely through at every course by headers

TABLE 2

Brick or Tile Required for 100 Sq. Feet of Wall.

SOLID BRICK WALLS		IDEAL WALLS				TILE AND STUCCO WALLS		BRICK VENEER ON TILE WALLS	
8-in. wall	12-in. wall	8-in. Ideal all-rolok wall	12½-in. Ideal all-rolok wall	8-in. Ideal rolok-bak wall	12½-in. Ideal rolok-bak wall	8-in. tile wall	12-in. tile wall	8-in. wall. Tile and Brick veneer	12-in. wall. Tile and Brick veneer
1271 brick	1926 brick	904 brick	1329 brick (type on plate 1) 1431 brick (type on plate 2)	1052 brick	1544 brick	*100 8x12x12-in. hollow tile	*100 12x12x12-in. hollow tile	703 brick *207 4x5x12-in. hollow tile	790 brick *207 8x5x12-in. hollow tile
Add cost of interior furring and lath.		Self-faced outside; no interior furring or lath needed.				Add cost of exterior stucco, interior furring and lath. *Number of tile given in Hollow Tile handbook.		Add cost of interior furring and lath. *Using co-efficient of 2.4 per sq. foot minus 1/7 for header courses.	

spaced 10¾ inches on center. In the 12½-in. Ideal all-rolok wall shown on Plate 1 the center web is bonded to either the inner or outer web at every course. Although the 12½-in. Ideal all-rolok wall shown on Plate 2 requires one brick more per square foot of area than that on Plate No. 1, it is a cheaper wall to construct, there being no bats to place that will show on the outside face. The wall shown on Plate 2 is not so well bonded on the centre web as the other type, but it is amply strong for all ordinary purposes.

Bond of All-Stretcher Courses, 12½" Ideal All-Rolok Wall:

47. For basement walls below grade alternate courses on both sides of the 12½" wall shown on Plate 1 may consist entirely of stretchers. For similar 12½" walls above grade, with one side only exposed, alternate courses on the back of the wall only may consist entirely of stretchers, the bond being preserved on the face by the use of bats.

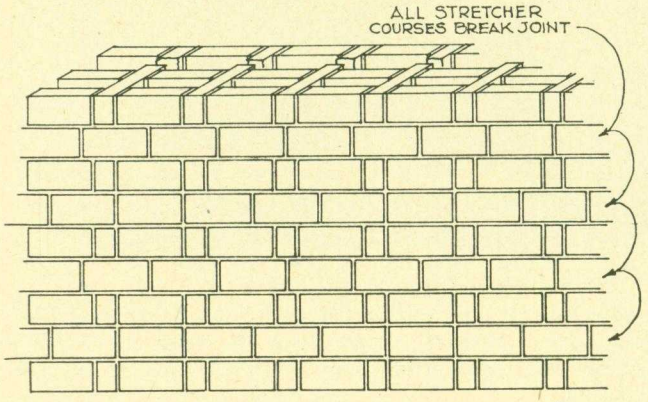


Figure 10.

48. It is important that the all-stretcher courses on the unexposed face break joint, as shown in Fig. 10. At every third stretcher it is seen that the difference in the unit of length will cause the vertical joints to coincide. By breaking the joints of the stretchers no more than three vertical joints will coincide, as shown. Such coinciding of vertical joints does not weaken the wall but rather strengthens it. (Par. 22-27, pages 29-30.)

Exposed Bond, Ideal Rolok-Bak Walls:

49. Any bond may be used with the Ideal rolok-bak wall. With common bond, "Flemish" header courses are recommended, these consisting of headers and stretchers placed alternately.

50. With Flemish bond the exposed headers in each 3rd or 6th course only should be through headers, the remainder being bats. This is the usual method employed with face brick in ordinary construction.

51. With English or English cross bond it is evident that through headers must occur at every 4th or 6th course, instead of every 3rd or 6th course as with other bonds. Where headers every 4th course are preferred, the arrangement shown in Fig. 11 should be used.

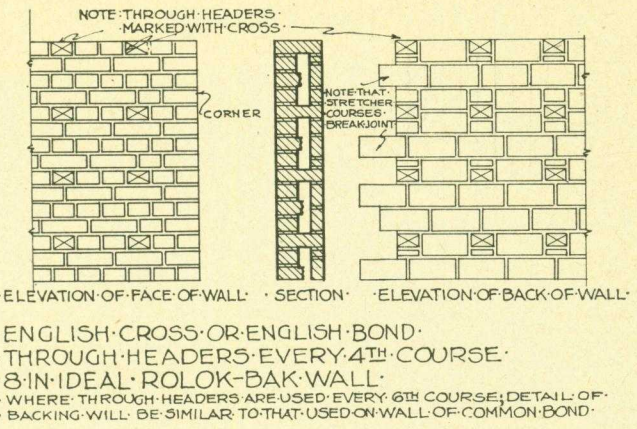

NOTE THROUGH HEADERS MARKED WITH CROSS
CORNER
NOTE THAT STRETCHER COURSES BREAK JOINT
ELEVATION OF FACE OF WALL
SECTION
ELEVATION OF BACK OF WALL
ENGLISH CROSS OR ENGLISH BOND
THROUGH HEADERS EVERY 4TH COURSE
8 IN IDEAL ROLOK-BAK WALL
WHERE THROUGH HEADERS ARE USED EVERY 6TH COURSE, DETAIL OF BACKING WILL BE SIMILAR TO THAT USED ON WALL OF COMMON BOND

Figure 11.

Header Courses as Joist Support, Ideal All-Rolok Wall:

52. In the Ideal all-rolok wall the joists may be supported on a full header course, this method having the advantage that the headers form a firestop at the story line.

53. Where the joists are supported on an offset in the wall (see typical construction at first floor level, Plate 4), the joints in the header course should be slushed full.

54. Where the wall is 8" thick above and below the joists (see typical construction at second floor level, Plate 3), the vertical joints between headers should be open in the center to help in securing a circulation of air and to break the through mortar joint at this point.

55. The all-header course may be a feature of the architectural design, and made to have an attractive appearance. (Fig. 40, page 53.) If preferred, however, some of the vertical joints in this course may be "blind" joints as shown on Plate 3 and the header course can thus be made to have the appearance of alternate headers and stretchers, or all stretchers.

Spandrel Walls:

56. In concrete floor systems it is sometimes necessary to place spandrel beams within the outside walls, concealed behind a 4" thickness of brickwork. Especially with inverted beams it is difficult to make such beams of effective width where the exterior wall is 8" thick. By placing the outside brick on edge and securely anchoring every third course, it will be possible in many cases to leave enough room for the inverted beam so that it can be placed in an 8" wall. (Fig. 12.) By this means the floor area may be increased and a considerable saving made in the cost of the building.

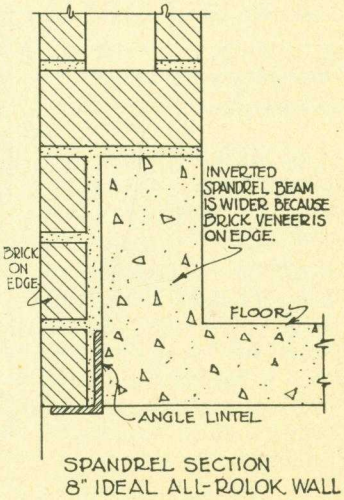


Figure 12.

Ideal Walls Save Beam Filling at First Story Level:

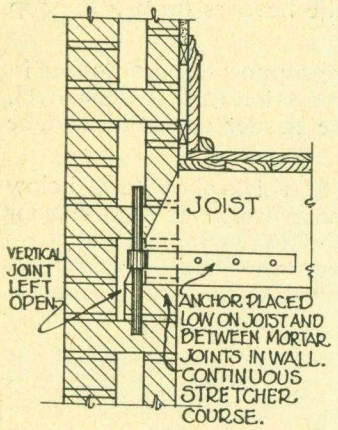
57. With walls which require furring it is necessary to fill between joists with brickwork at the first story level to form a firestop. By eliminating furring, the necessity of beam filling at this point is also eliminated.

Concealed Joist Support, Ideal All-Rolok Wall:

58. In cases where fire stopping at the floor line is not necessary, such as where there are no openings in the wall below the joists, the latter may be supported on one, two or three stretcher courses laid flat, according to the exact height of the joists. (See Plate 3.)

Exposed and Concealed Joist Support, Ideal Rolok-Bak Wall:

59. On Plate 3 is shown the use of an all header course as joist support. As in the case of the Ideal all-rolok wall, this course may be made an attractive feature of the design, with headers exposed. Headers may be placed in and out alternately, a band of three or four courses of headers introduced or other appropriate treatment employed.


JOIST
VERTICAL JOINT LEFT OPEN
ANCHOR PLACED LOW ON JOIST AND BETWEEN MORTAR JOINTS IN WALL.
CONTINUOUS STRETCHER COURSE.

CONCEALED JOIST SUPPORT FORMING FIRE STOP IDEAL ROLOK-BAK WALL.

Figure 13.

60. With the Ideal rolok-bak wall the all-header course is not, however, necessary to obtain a firestop at the floor line. As shown in Fig. 13, a flat stretcher can be laid on the inside face of the wall at any point desired, to serve as a joist support and firestop. The vertical joint should be left open as shown in order not to prevent the slow flow of air circulation.

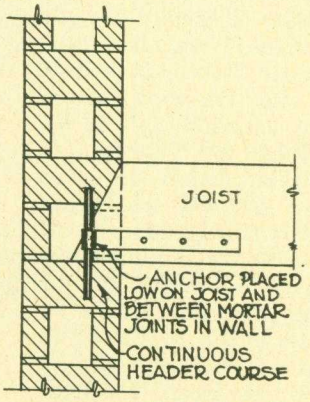
Joist Anchors:

61. The usual type of joist anchor may be used with either Ideal all-rolok or Ideal rolok-bak walls, as shown in Figs. 13 and 14.

Window and Door Frames:

62. Stock window and door frames can be used in both types of Ideal walls.

63. It is possible to keep the face of the trim flush with the plaster with the Ideal all-rolok wall if desired, and thus produce a charming and unusual effect at little or no extra cost.



DETAIL OF JOIST ANCHOR IN 8" IDEAL ALL-ROLOK WALL

Figure 14.

64. By making the brick opening a little wider and higher, and setting out the frame, a stock double hung window used in the Ideal rolok-bak wall can be made to preserve the usual relation of the back of the frame being flush with the finished plaster. In this case a windstop is nailed to the back of the frame. This detail has much historic precedent.

65. Where the usual outside window reveal is preserved with the Ideal rolok-bak wall, a special backband will be required when a stock frame is used.

Supports Over Openings:

66. In the plates, the inner and outer web are shown supported on steel angles but any of the standard methods may be employed. Openings may be arched, or a combination of an arch for the outside course, and a wood lintel inside with relieving arch over, may be used.

Firestopping Window and Door Frames:

67. As shown on the plates, effectual fire-stopping of all openings consists of brick chips slushed in as the wall goes up. This fire-stopping need not be more than 1½ inches or 2 inches thick. (See isometric drawing, Plate 5.)

Nailing Blocks and Grounds:

68. One by four or two by four nailing blocks can easily be built in Ideal walls at any point desired as the work progresses and makes easy the attachment of grounds.

Mortar and Joints for Ideal Walls:

69. Portland cement-lime mortar should be used below grade; lime mortar may be used above grade.

70. All mortar joints in Ideal walls should be filled. A feature of this wall is the ease with which this may be done. Raked joints may be used with Ideal rolok-bak and Ideal all-rolok walls. (Par. 30, page 48.)

71. Reasonable care should be used by the mason to avoid dropping mortar inside the wall cavity. The bricklayer should be instructed regarding this, in order not to defeat the purpose of the wall by affording contact with the inner and outer webs even at this point.

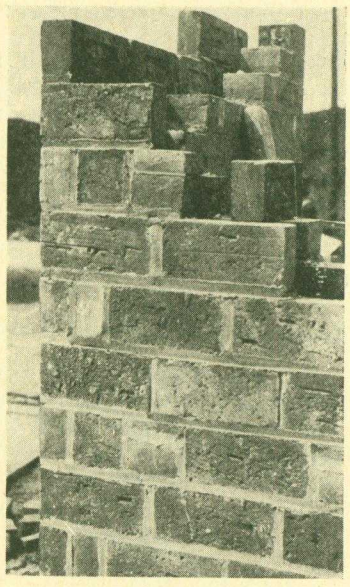


Figure 15. Backing of Ideal all-rolok wall, headers every 6th course.

Use Only Burned Clay Brick:

72. The Ideal wall is devised to take advantage of the enormous strength of burned clay brick. Ideal walls should never be built of unburned imitation brick, which are porous, weak and unsatisfactory in performance and appearance.

73. Lay all brick moist, except impervious brick. This is important, especially when wall is built in hot weather, to prevent too quick absorption of the water in the mortar.

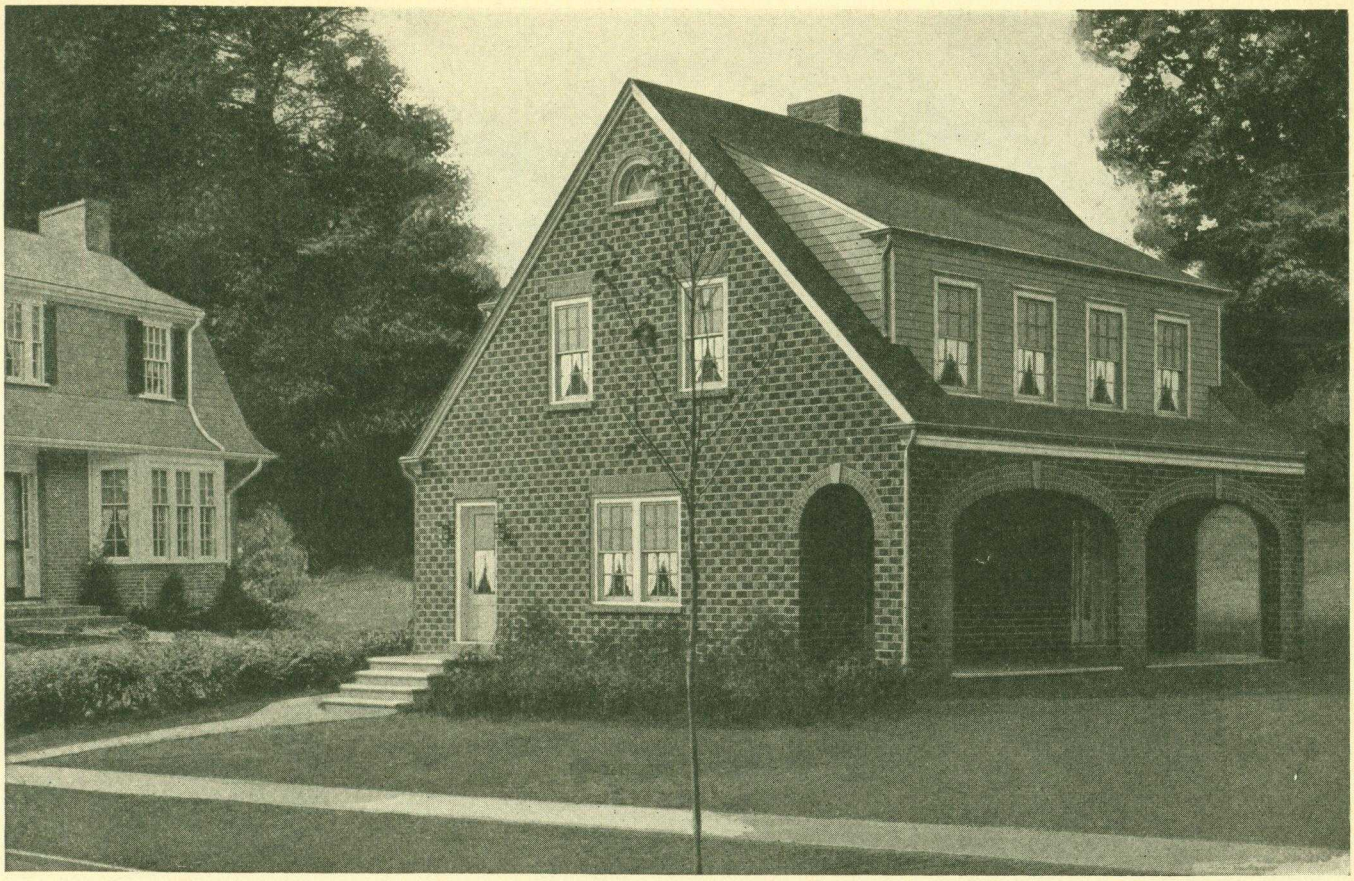


Figure 16. Ideal wall home, built with 8" walls, at Phillipsburg, N. J., Paul R. Smith, Architect.

ALL BUILDING CODES SHOULD PERMIT EIGHT INCH WALLS FOR RESIDENCES

Brick Homes Benefit Communities:

1. It is greatly to the advantage of any community to have its homes constructed of brick. In the fire zones of cities only homes with fire safe walls are allowed. Brick reduces the danger of fire spreading from one house to another and so makes cities safer. Because of the permanent character of brick, a group of homes with brick walls does not get the run down appearance of a group of less permanent homes. It is impossible to say whether a brick house is five or fifty years old. Brick homes thus stabilize real estate values.

Codes Should Not Penalize Brick:

2. Brick is a rich man's material and essentially a poor man's material also. The rich man wants a brick home because of its beauty and air of distinction and permanence. The poor man wants a brick home because it saves him money. Yet some codes make it hard for the poor man to have a brick home.

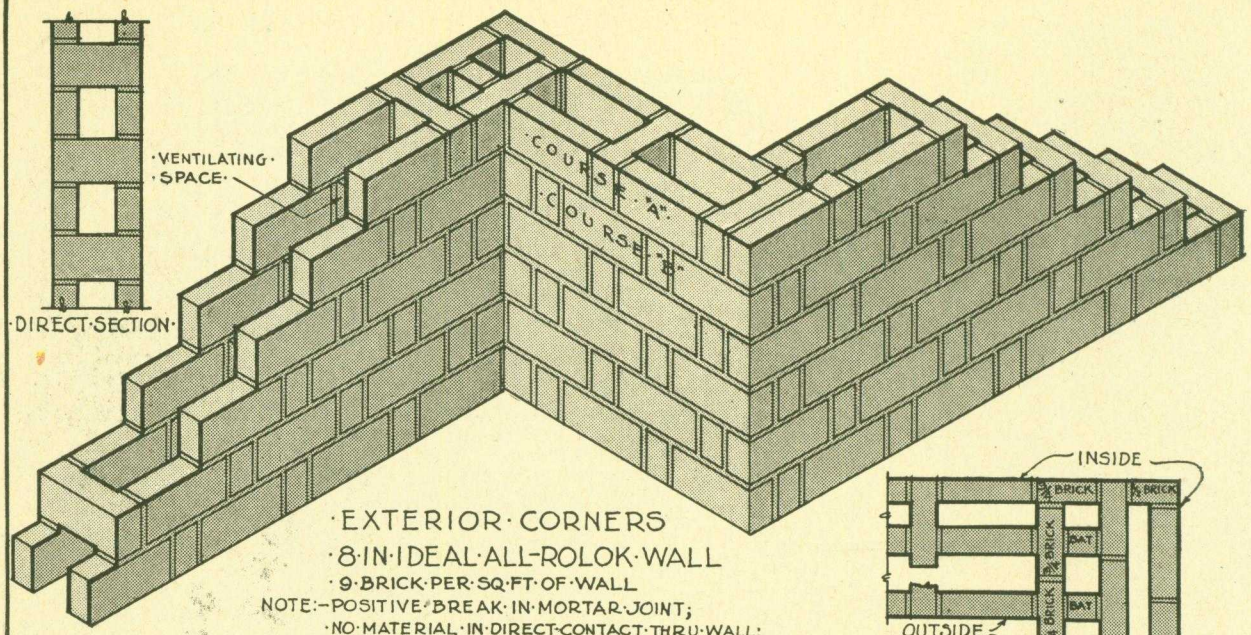
3. Some codes require more material and consequently more labor than is necessary in dwelling construction. Such codes, by placing a handicap on good brick construction, tend to undo the educational work now being carried on by fire prevention authorities and by this and other associations, the objects of which are to impress on the building public the economy of permanent fire-resistive construction.

Many Large Cities Permit Eight Inch Walls:

4. That a thickness of 8" for the brick walls of the usual home, above the basement, is ample, both for the first and second stories, is proved by endless examples in practice and by theory.

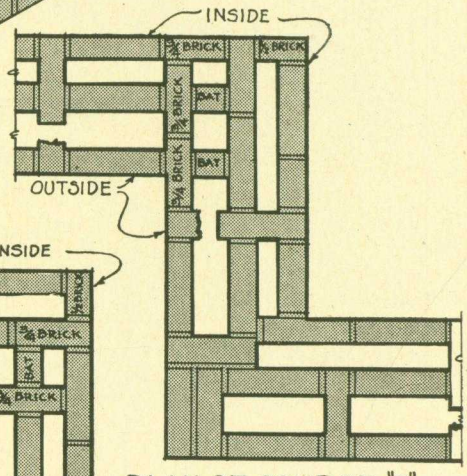
5. Some of the following data is taken from building codes and some from returns received direct from building officials. Thirty-five cities allow an eight inch wall for both stories of a two-story house. These are: Baltimore, Birmingham, Boston, Cambridge, Columbus, Cleveland, Detroit, Minneapolis, New York City, Philadelphia, Seattle, Spokane, Pittsburgh, Tacoma, Washington, D. C., Wilmington, Richmond, Syracuse, Tampa, Worcester, New Haven, Manchester, Rochester, Toledo, Duluth, Hartford, Rock Island, Lynn, Cincinnati, Trenton, Portland, Buffalo, Dayton, Camden, New Bedford and New Orleans. Many thousands of homes have

(Continued on page 23)

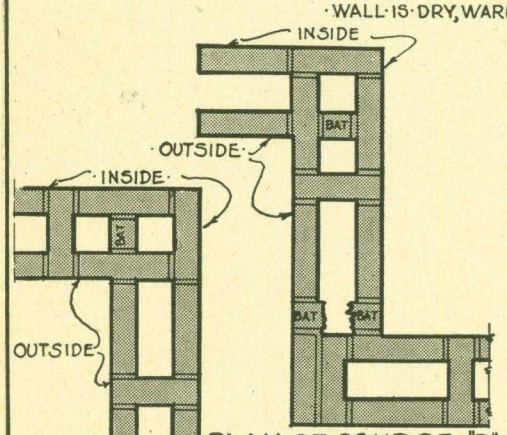


EXTERIOR CORNERS
8 IN IDEAL ALL-ROLOK WALL
9 BRICK PER SQ FT OF WALL

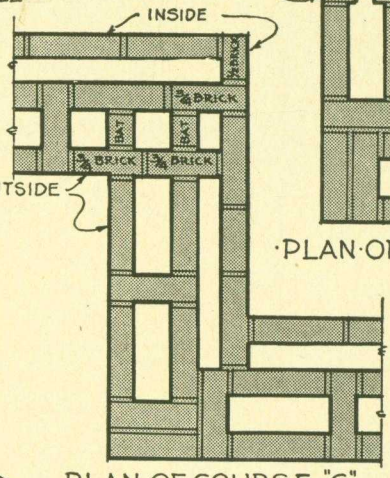
NOTE:–POSITIVE BREAK IN MORTAR JOINT;
NO MATERIAL IN DIRECT CONTACT THRU WALL;
VENTILATING AIR SPACE
WALL IS DRY, WARM AND COMFORTABLE



PLAN OF COURSE "D"



PLAN OF COURSE "B"



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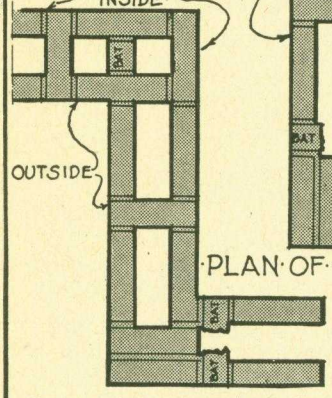
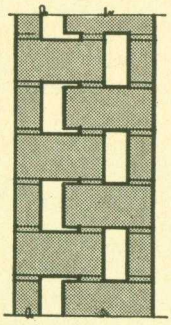
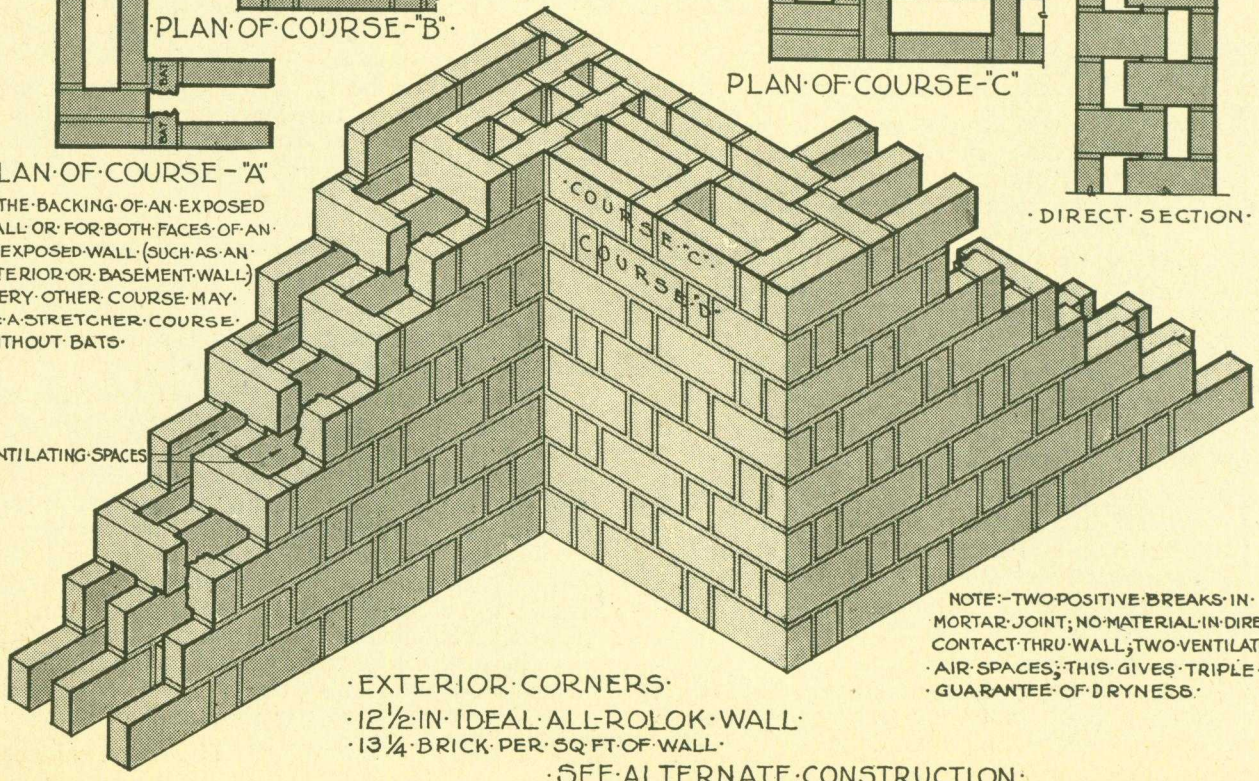


PLAN OF COURSE – "A"

IN THE BACKING OF AN EXPOSED WALL OR FOR BOTH FACES OF AN UNEXPOSED WALL (SUCH AS AN INTERIOR OR BASEMENT WALL) EVERY OTHER COURSE MAY BE A STRETCHER COURSE WITHOUT BATS



DIRECT SECTION

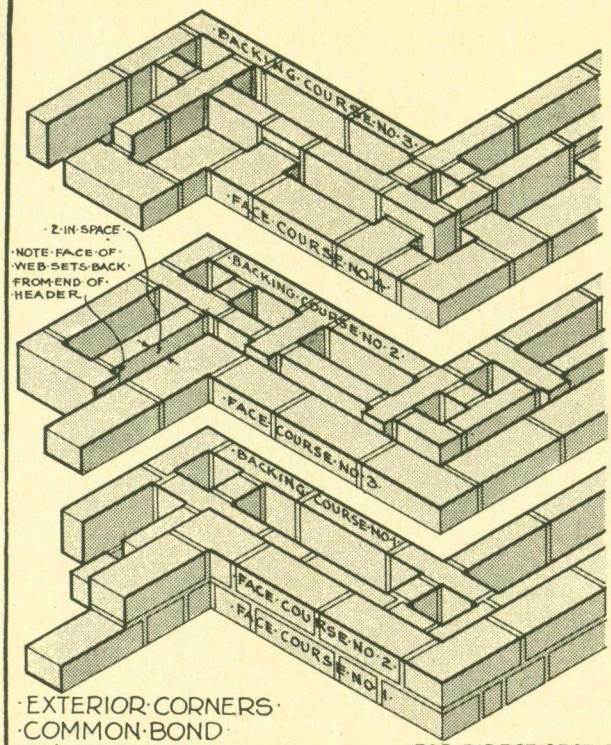


NOTE:–TWO POSITIVE BREAKS IN MORTAR JOINT; NO MATERIAL IN DIRECT CONTACT THRU WALL; TWO VENTILATING AIR SPACES; THIS GIVES TRIPLE GUARANTEE OF DRYNESS

EXTERIOR CORNERS
12½ IN IDEAL ALL-ROLOK WALL
13¼ BRICK PER SQ FT OF WALL

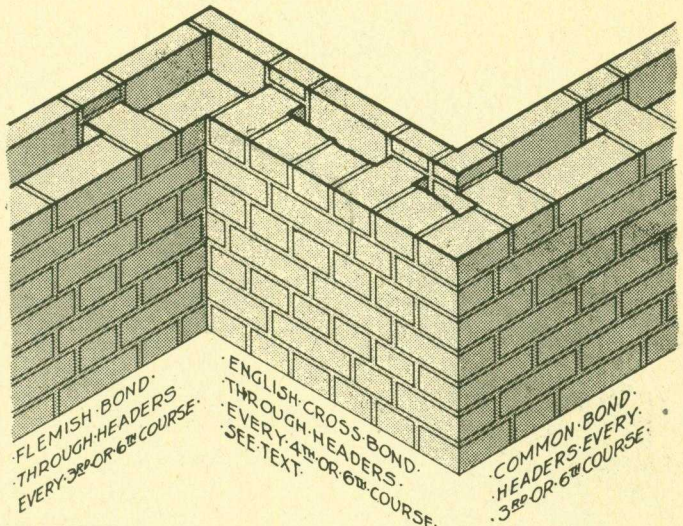
SEE ALTERNATE CONSTRUCTION ON PLATE NO 2

PLATE NO 1


BACKING COURSE NO. 3
FACE COURSE NO. 4
2 IN SPACE
NOTE FACE OF WEB SETS BACK FROM END OF HEADER
BACKING COURSE NO. 2
FACE COURSE NO. 3
BACKING COURSE NO. 1
FACE COURSE NO. 2
FACE COURSE NO. 1

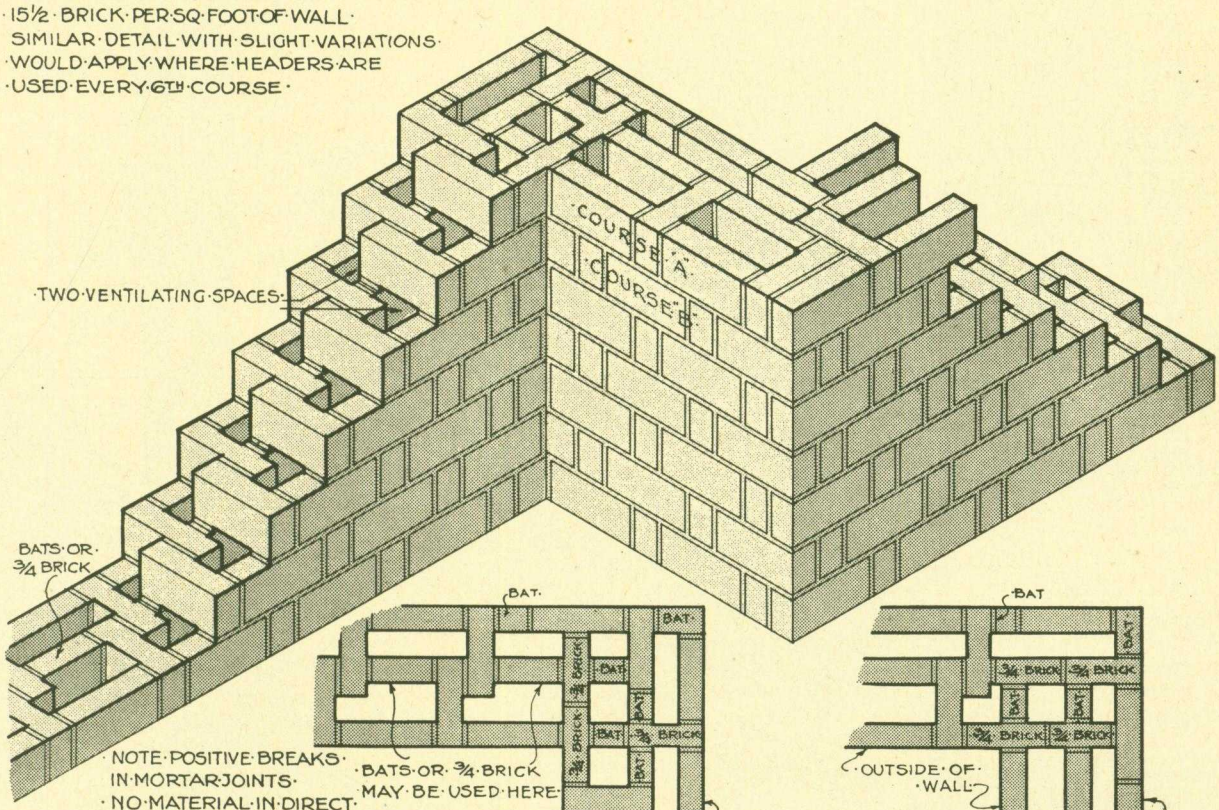
EXTERIOR CORNERS
COMMON BOND
12½ IN ROLOK-BAK WALL
HEADERS EVERY 3RD COURSE
15½ BRICK PER SQ FOOT OF WALL
SIMILAR DETAIL WITH SLIGHT VARIATIONS WOULD APPLY WHERE HEADERS ARE USED EVERY 6TH COURSE

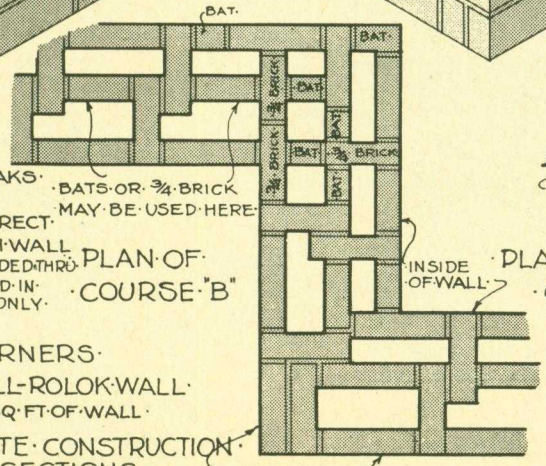
FOR DIRECT SECTIONS SEE PLATE NO 4



EXTERIOR CORNERS
8 IN ROLOK-BAK WALL
FLEMISH, ENGLISH-CROSS AND COMMON BOND

FOR DIRECT SECTIONS SEE PLATE NO 4

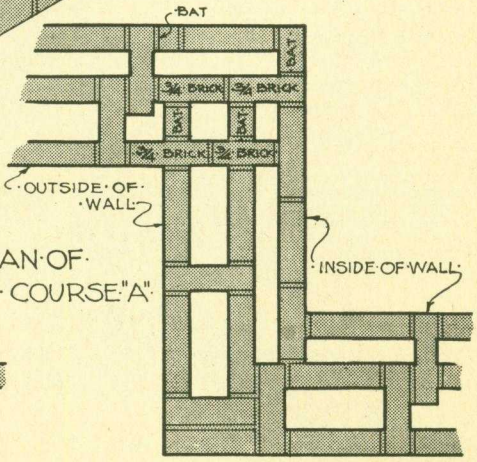




NOTE POSITIVE BREAKS IN MORTAR JOINTS
NO MATERIAL IN DIRECT CONTACT THROUGH WALL
EVERY COURSE BONDED THRU WALL . . . . BATS USED IN INTERIOR OF WALL ONLY

BATS OR ¾ BRICK MAY BE USED HERE

PLAN OF COURSE "B"

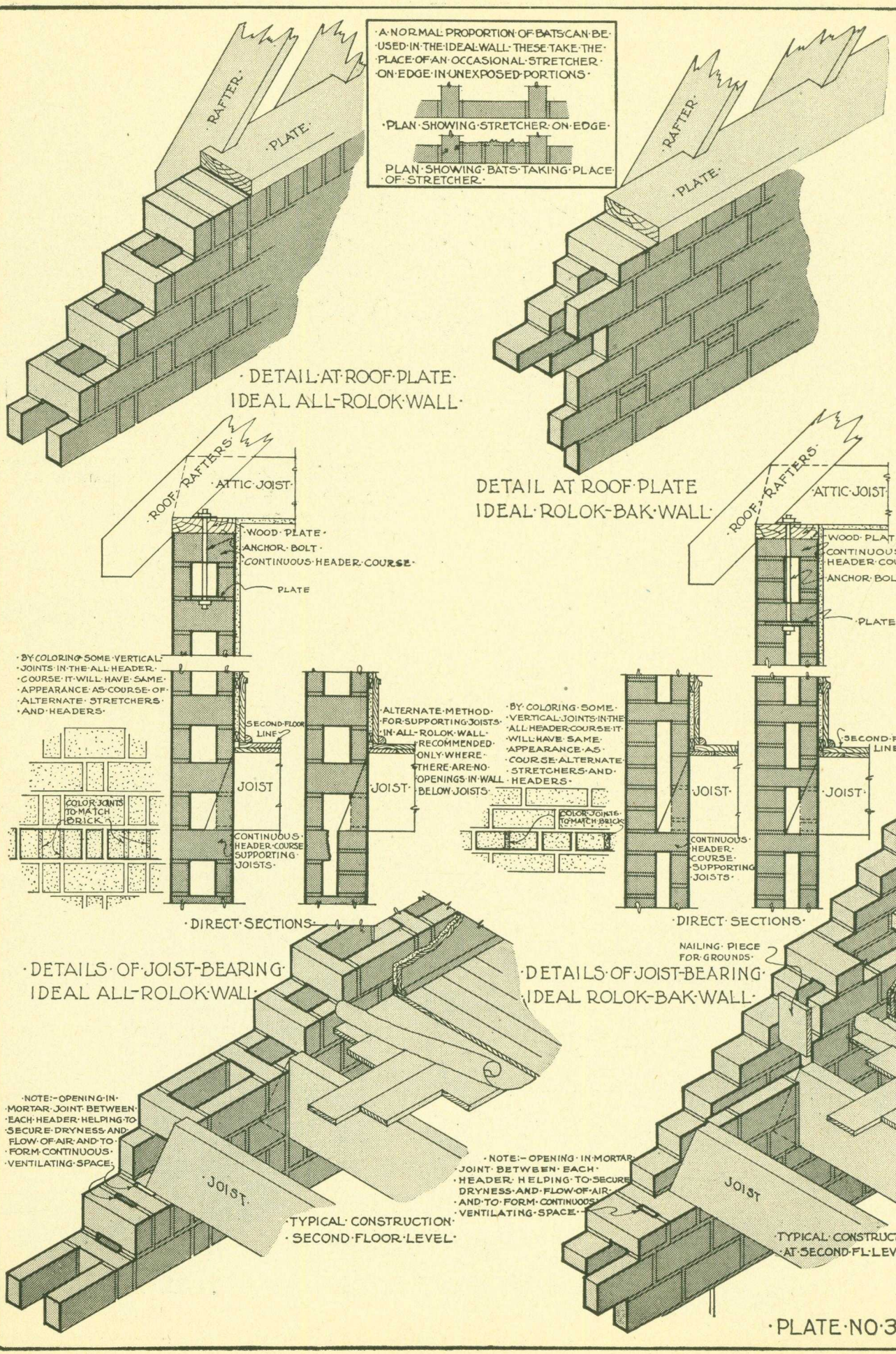


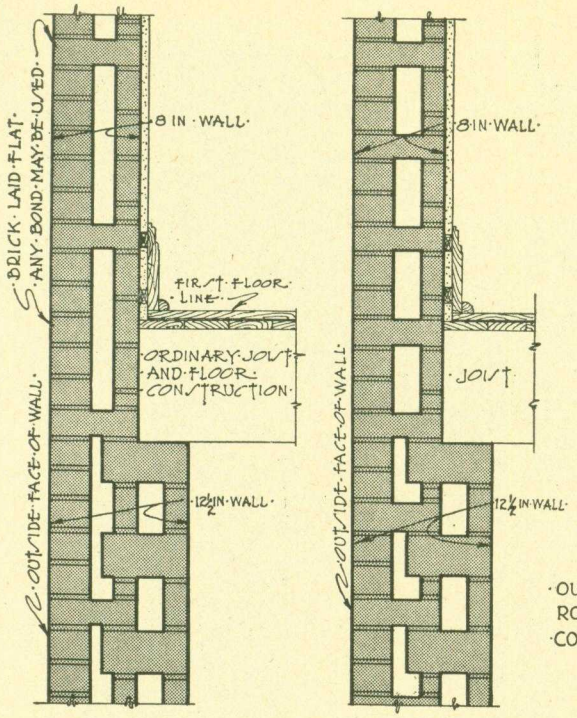
PLAN OF COURSE "A"

EXTERIOR CORNERS
12½ IN IDEAL ALL-ROLOK WALL
14¼ BRICK PER SQ FT OF WALL

FOR ALTERNATE CONSTRUCTION AND DIRECT SECTIONS SEE PLATE NO 1

PLATE NO 2


A NORMAL PROPORTION OF BATS CAN BE USED IN THE IDEAL WALL. THESE TAKE THE PLACE OF AN OCCASIONAL STRETCHER ON EDGE IN UNEXPOSED PORTIONS.
PLAN SHOWING STRETCHER ON EDGE
PLAN SHOWING BATS TAKING PLACE OF STRETCHER.
RAFTER
PLATE
DETAIL AT ROOF PLATE
IDEAL ALL-ROLOK WALL
DETAIL AT ROOF PLATE
IDEAL ROLOK-BAK WALL
ROOF RAFTERS
ATTIC JOIST
WOOD PLATE
ANCHOR BOLT
CONTINUOUS HEADER COURSE
PLATE
BY COLORING SOME VERTICAL JOINTS IN THE ALL HEADER COURSE IT WILL HAVE SAME APPEARANCE AS COURSE OF ALTERNATE STRETCHERS AND HEADERS
SECOND FLOOR LINE
JOIST
COLOR JOINTS TO MATCH BRICK
CONTINUOUS HEADER COURSE SUPPORTING JOISTS
ALTERNATE METHOD FOR SUPPORTING JOISTS IN ALL ROLOK WALL RECOMMENDED ONLY WHERE THERE ARE NO OPENINGS IN WALL BELOW JOISTS
DIRECT SECTIONS
BY COLORING SOME VERTICAL JOINTS IN THE ALL HEADER COURSE IT WILL HAVE SAME APPEARANCE AS COURSE ALTERNATE STRETCHERS AND HEADERS
SECOND FL LINE
DIRECT SECTIONS
DETAILS OF JOIST-BEARING
IDEAL ALL-ROLOK WALL
NOTE:- OPENING IN MORTAR JOINT BETWEEN EACH HEADER HELPING TO SECURE DRYNESS AND FLOW OF AIR AND TO FORM CONTINUOUS VENTILATING SPACE
JOIST
TYPICAL CONSTRUCTION SECOND FLOOR LEVEL
DETAILS OF JOIST-BEARING
IDEAL ROLOK-BAK WALL
NAILING PIECE FOR GROUNDS
NOTE:- OPENING IN MORTAR JOINT BETWEEN EACH HEADER HELPING TO SECURE DRYNESS AND FLOW OF AIR AND TO FORM CONTINUOUS VENTILATING SPACE
JOIST
TYPICAL CONSTRUCTION AT SECOND FL LEVEL
PLATE NO 3

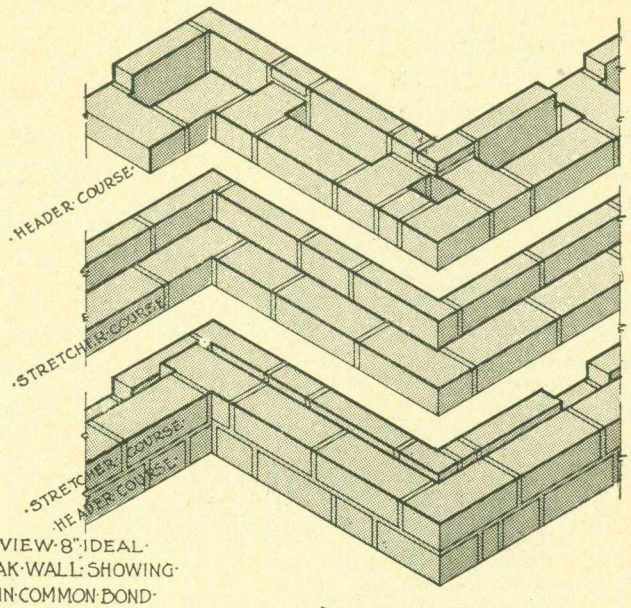


DIRECT SECTION

IDEAL ROLOK-BAK WALL
HEADERS EVERY 6TH COURSE

DIRECT SECTION

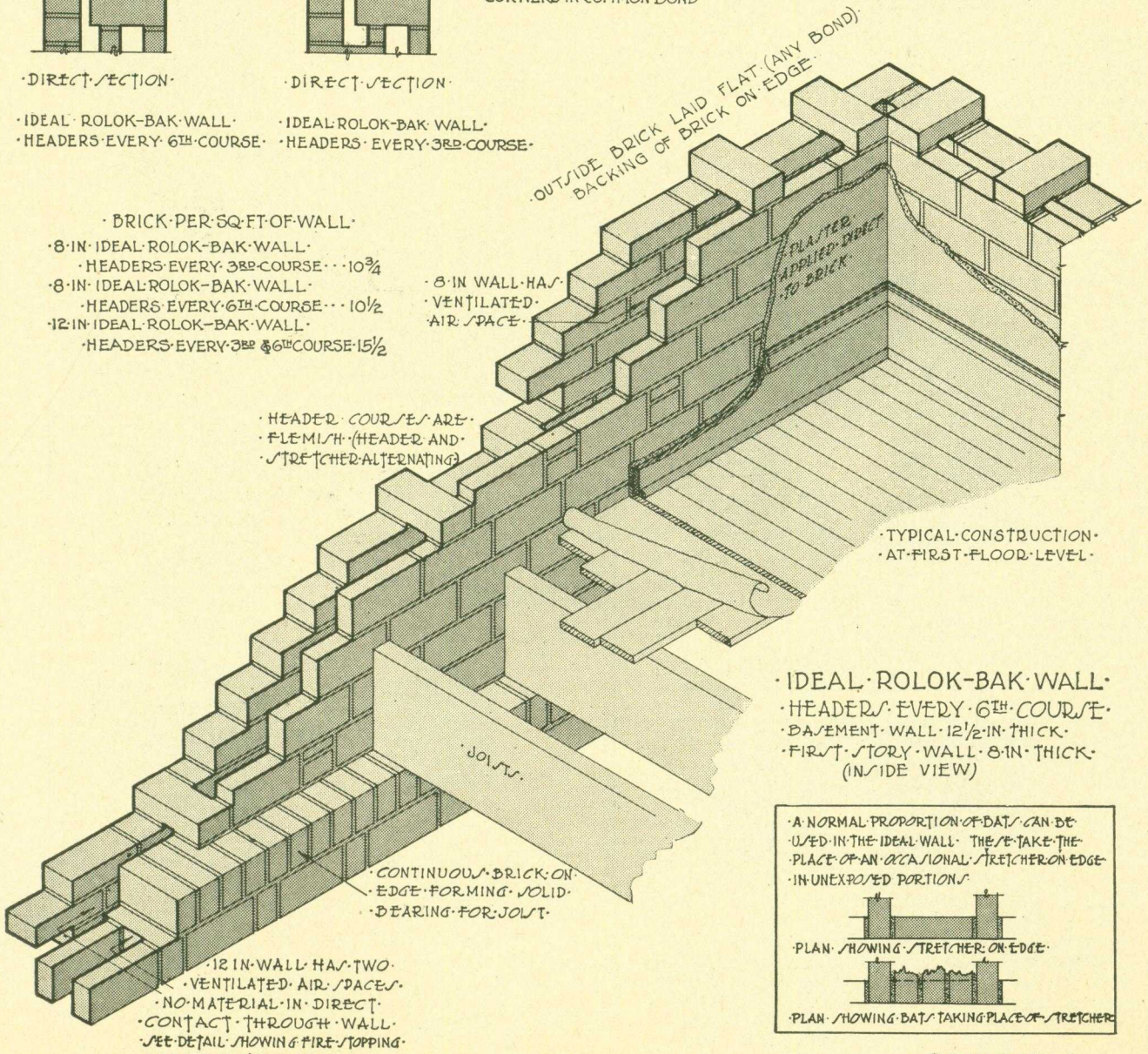
IDEAL ROLOK-BAK WALL
HEADERS EVERY 3RD COURSE



OUTSIDE VIEW 8" IDEAL ROLOK-BAK WALL SHOWING CORNERS IN COMMON BOND

BRICK PER SQ FT OF WALL

8 IN IDEAL ROLOK-BAK WALL
HEADERS EVERY 3RD COURSE . . . 10¾
8 IN IDEAL ROLOK-BAK WALL
HEADERS EVERY 6TH COURSE . . . 10½
12 IN IDEAL ROLOK-BAK WALL
HEADERS EVERY 3RD & 6TH COURSE 15½


OUTSIDE BRICK LAID FLAT (ANY BOND) BACKING OF BRICK ON EDGE
PLASTER APPLIED DIRECT TO BRICK
8 IN WALL HAS VENTILATED AIR SPACE
HEADER COURSES ARE FLEMISH (HEADER AND STRETCHER ALTERNATING)
TYPICAL CONSTRUCTION AT FIRST FLOOR LEVEL
JOISTS
CONTINUOUS BRICK ON EDGE FORMING SOLID BEARING FOR JOIST
12 IN WALL HAS TWO VENTILATED AIR SPACES
NO MATERIAL IN DIRECT CONTACT THROUGH WALL
SEE DETAIL SHOWING FIRE STOPPING OF BASEMENT WINDOWS

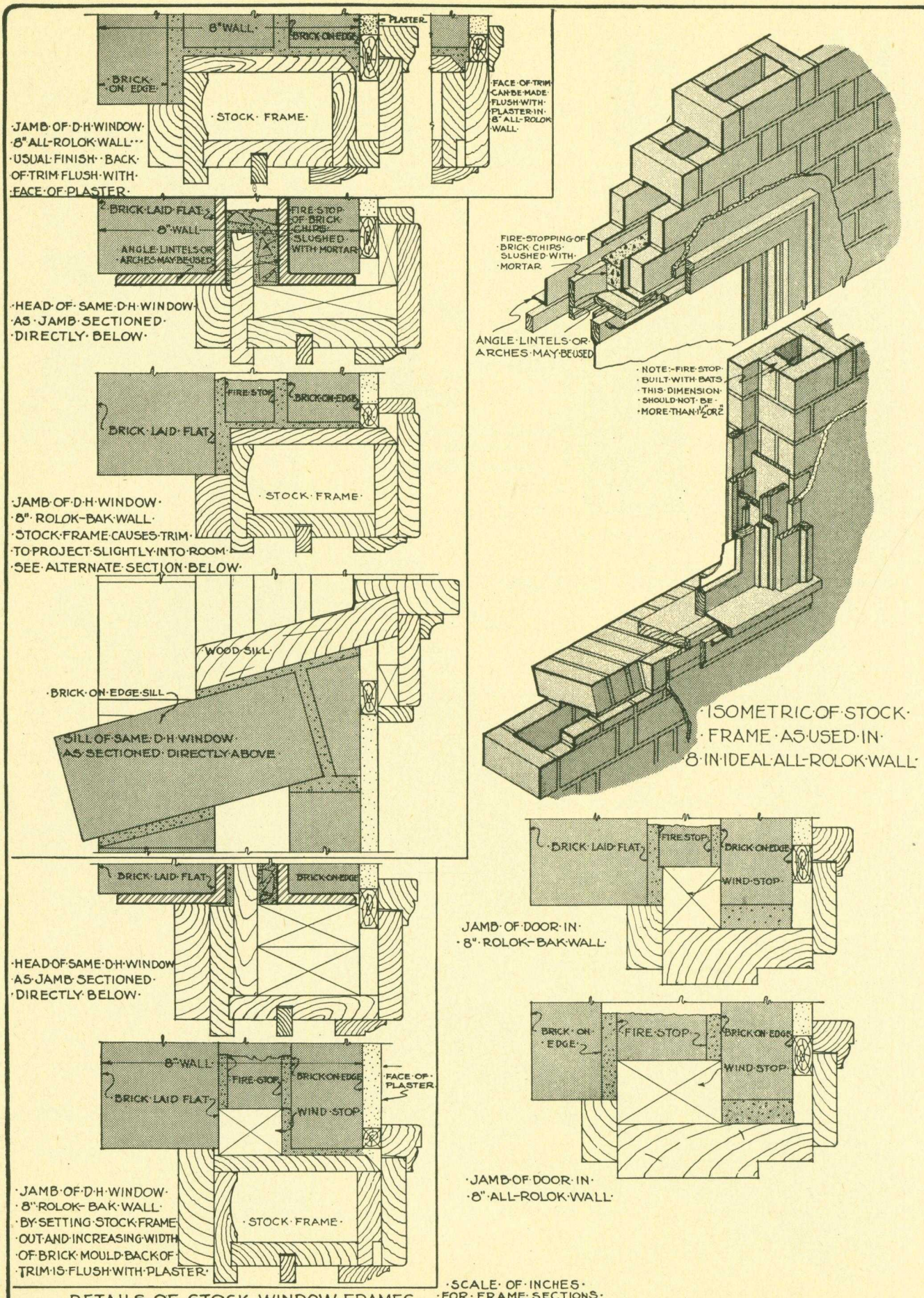
IDEAL ROLOK-BAK WALL
HEADERS EVERY 6TH COURSE
BASEMENT WALL 12½ IN THICK
FIRST STORY WALL 8 IN THICK
(INSIDE VIEW)

A NORMAL PROPORTION OF BATS CAN BE USED IN THE IDEAL WALL THESE TAKE THE PLACE OF AN OCCASIONAL STRETCHER ON EDGE IN UNEXPOSED PORTIONS

PLAN SHOWING STRETCHER ON EDGE

PLAN SHOWING BATS TAKING PLACE OF STRETCHER

PLATE NO 4


8" WALL
BRICK ON EDGE
PLASTER
BRICK ON EDGE
STOCK FRAME
FACE OF TRIM CAN BE MADE FLUSH WITH PLASTER IN 8" ALL-ROLOK WALL
JAMB OF D.H. WINDOW 8" ALL-ROLOK WALL ··· USUAL FINISH ·· BACK OF TRIM FLUSH WITH FACE OF PLASTER
BRICK LAID FLAT
8" WALL
ANGLE LINTELS OR ARCHES MAY BE USED
FIRE STOP OF BRICK CHIPS SLUSHED WITH MORTAR
HEAD OF SAME D.H. WINDOW AS JAMB SECTIONED DIRECTLY BELOW
FIRE STOP
BRICK ON EDGE
BRICK LAID FLAT
STOCK FRAME
JAMB OF D.H. WINDOW 8" ROLOK-BAK WALL STOCK FRAME CAUSES TRIM TO PROJECT SLIGHTLY INTO ROOM SEE ALTERNATE SECTION BELOW
WOOD SILL
BRICK ON EDGE SILL
SILL OF SAME D.H. WINDOW AS SECTIONED DIRECTLY ABOVE
FIRE-STOPPING OF BRICK CHIPS SLUSHED WITH MORTAR
ANGLE LINTELS OR ARCHES MAY BE USED
NOTE:-FIRE STOP BUILT WITH BATS THIS DIMENSION SHOULD NOT BE MORE THAN 1½"
ISOMETRIC OF STOCK FRAME AS USED IN 8 IN IDEAL ALL-ROLOK WALL
BRICK LAID FLAT
BRICK ON EDGE
HEAD OF SAME D.H. WINDOW AS JAMB SECTIONED DIRECTLY BELOW
8" WALL
FIRE STOP
BRICK ON EDGE
FACE OF PLASTER
BRICK LAID FLAT
WIND STOP
JAMB OF D.H. WINDOW 8" ROLOK-BAK WALL BY SETTING STOCK FRAME OUT AND INCREASING WIDTH OF BRICK MOULD BACK OF TRIM IS FLUSH WITH PLASTER
STOCK FRAME
BRICK LAID FLAT
FIRE STOP
BRICK ON EDGE
WIND STOP
JAMB OF DOOR IN 8" ROLOK-BAK WALL
BRICK ON EDGE
FIRE STOP
BRICK ON EDGE
WIND STOP
JAMB OF DOOR IN 8" ALL-ROLOK WALL
SCALE OF INCHES FOR FRAME SECTIONS
6 5 4 3 2 1 0

DETAILS OF STOCK WINDOW FRAMES AS USED IN 8 IN IDEAL WALLS

PLATE NO 5

(*Continued from page 17*)

been constructed in these cities with eight inch walls and many hundreds of thousands of people find them comfortable and satisfactory. No city which has adopted the eight inch wall has ever changed back to the twelve inch wall.

Weather Resistive and Strong:

6. Taking the other extreme, some cities require the first story wall of a dwelling house to be 16 inches thick, and many cities require a twelve inch wall at the first story and eight above. In the light of experience, a building code which insists on these things insists on a waste of material and money and encourages inferior construction.

7. An exterior wall must support the floors above and form an effective barrier against the elements. The fact that eight inch walls are allowed for the second story or for bungalow walls, indicates that such walls are considered in every city satisfactory for excluding the elements. The question of strength remains. Disregarding the experience of the cities mentioned, which would constitute a satisfactory reply in itself, see test results on the following pages on the actual strength of brickwork.

8. Experience and theory amply prove that the eight inch wall is weather resistive and possesses much more strength than the loads of a residence can ever develop.

9. For further proof, if proof be needed, that the eight-inch wall is satisfactory above grade for two-story and attic residences, the following is a statement by D. Knickerbacker Boyd, Architect, who during the war acted as Chief of the Materials Information Section of the U. S. Housing Corporation:

10. "Of the thousands of houses built by the U. S. Housing Corporation and the Housing Division of the Emergency Fleet Corporation and the many thousands more for which drawings were made, the eight inch wall was the invariable rule. This thickness of wall was adopted after thorough investigation and most mature consideration and was even made to apply in several instances to localities where unfortunately at the time the minimum requirements were for thirteen inch walls. The Building authorities in these localities in most cases voluntarily conceded to the requirement of the Government that these houses should and could be built of this eight inch thickness—in spite of any prevailing provision to the contrary."

11. There is another important consideration; that the extra space taken up by the twelve inch thickness reduces the area of the rooms in the house. In the case of a house twenty by thirty feet, approximately thirty-one square feet of area is thus lost on each story, an area equal to a small bathroom or several good closets.

12. The eight inch brick wall is enormously strong; it is unquestionably fire-safe; it now forms warm and dry walls for the homes of multitudes of people and gives a man of small or average means free choice of his building material without taxing his preference for good construction. Building codes not already permitting this thickness of brick wall should be amended so that both inside and outside the fire zones the eight inch solid or Ideal wall will be allowed.

Recommended Thickness of Walls:

13. The walls of residential buildings, above the basement, where such walls do not exceed thirty feet in height, may be safely built of solid brickwork eight inches thick. A gable of moderate height may be added to the above without increasing the safe minimum allowable thickness of the walls. Basement walls should ordinarily be twelve inches thick, unless the basement is shallow or soil conditions very favorable.

Thin Brick Partitions:

14. For interior bearing or non-bearing partitions in residences the 4" brick wall is strong and much more fire resistive than partitions of wooden studs and their use is recommended for at least some of the partitions in residences. Such partitions have ample strength to carry floor joists at the first floor, second floor and attic levels. They must either extend up from the basement floor or be carried on steel joists at the basement ceiling level, supported on brick piers.

TABLE 3.
Strength of Thin Brick Walls

Tests Made by British Government on Strength of Walls 2⅝"†† and 4½"†† Thick.
††Dimensions of English Brick

Thickness of wall	Brick	Mortar	Crushing Strength of 9" x 9" cubes-Lb. per sq. in.	Age of cubes when tested—Days	Crushing Strength of wall 14" wide, 8' 6" high—Lb. per sq. in.	Age of wall compression test—Days	‖ Horizontal pull to break wall 3' 6" wide, 8' 6" high—Lbs.	Vertical load applied—in tons per ft. run—while wall was tested under horizontal pull	Age of wall tested under horizontal pull—Days
4½ in.	* Stock	1:3 Cement	770	26	638	24	895	2 tons	34
4½ in.	* Stock	1:6 Cement	720	26	562	23	791	1 ton	41
4½ in.	† Fletton	1:3 Cement	1,530	26	1,040	24	781	1 ton	39
4½ in.	† Fletton	1:6 Cement	1,250	26	930	23	705	1 ton	36
4½ in.	† Fletton	1:3 Lime	1,050	22	330	24	375	1 ton	27
2⅝ in. cast in one piece	†† Fletton on edge	1:3 Cement	1,470	29	1,040	23	553	1 ton	44

* Hard burned stock brick, compressive strength 1,460 lb. sq. in.; soft burned 760 lb. sq. in—both types of brick used in each wall.
† Compressive strength 3,300 lb. sq. in.
†† Compressive strength 3,500 lb. sq. in.
‖ The horizontal load was applied at the center of the wall by means of a chain attached to a horizontal timber for spreading the load at the back of the wall.

In European countries it is standard construction to use 4" brick walls for bearing and non-bearing partitions in residences and other buildings having only moderate floor loads and ordinary story heights. Such walls are frequently built three stories high and support the joists at each floor level. Non-bearing partitions of brick on edge are used extensively also.

BRICK IS BEST FOR FIRE-RESISTIVE AND SLOW BURNING CONSTRUCTION

1. The scope of this book permits of only the briefest mention of this type of building, which may include industrial buildings, schools, hotels, apartment houses, social buildings and many other structures.

Brick, Highest Class Construction:

2. Modern industrial structures are built with due regard to the advertising value of a dignified design. Standing in well kept grounds, such buildings are a distinct asset to any business.

3. Economy of construction and safety against fire are essential qualities in all types of buildings under this class. The safety of the occupants is one of the most important factors in the construction of any building.

4. Brick assists in the carrying out of any architectural conception by the beauty of its surface.

5. Brick is the most economical fire-resistive material that can be used for foundation walls, bearing walls, interior and exterior piers, curtain walls and for fire-resistive column protection.

6. Whether the floor construction is to be of steel, concrete or mill construction, advantage may with profit be taken of the economy and superior qualities of brick walls and brick piers above and below grade.

Inspection Easy During Construction:

7. Building brickwork is a clean and neat operation, with nothing "messy" about it. The integrity of brickwork is apparent. It makes a job that is excellent in appearance and in fact. Every portion is in plain sight during erection, making inspection easy. (See also pars. 1-17, pages 8 to 9.)

Brick Resists Blows and Impact:

8. In many industrial buildings and garages the interior walls have to resist impact and blows. Brick will take heavy punishment without material damage, because the blows are resisted by the inertia of a well bonded mass.

Brick Resists Direct Pull:

9. Brick makes the strongest wall to which to anchor wood guards, shafting, plumbing work, wall radiators, etc. It can also be plugged without damage and develops great resistance to direct pull, owing to the fact that brick is laid in small units, making a thoroughly bonded construction. Nailing blocks are also easily built into solid or Ideal walls.

Window and Door Frames Easily Set In Brick:

10. Brick is the only satisfactory material for walls in which windows or door openings occur or in which such openings might be placed subsequently. Steel or wood frames are set and bricked in as the wall goes up, the brickwork being fitted accurately and easily to the frames. The numerous courses also make it easy to have the joints coincide with the sill and head lines of windows or other openings.

Brick Piers:

11. Attention is specially directed to the advantage of using brick piers, either solid or hollow, laid with brick on edge. (Pars. 22-27 and Tables 7 and 8, pages 29 and 30.)

Brick Column Protection:

12. Column protection one brick (3¾") thick, brick laid flat, is given an official five hour fire resistance rating. (See report of tests, pages 32-33.)

13. When erecting a steel frame building with fire resistive curtain or spandrel walls, the brick protection for engaged columns is, of course, built up with the brick walls, eliminating the expense of special operations. Brick protection for independent columns is quickly and economically erected.

Interior Finish:

14. Plaster can be applied directly to a brick surface, without any chipping or other expensive preparation of surface and with no uncertainty as to whether the plaster will stay on.

15. In many cases the beautiful natural surface of the brickwork may be taken advantage of for interior finish, either for the whole interior of the building or for special rooms. The brick surface may be laid in a simple or elaborate bond or effective special designs may be worked out. In any case the advantage of a continuous surface of attractive brickwork for walls and engaged or independent column coverings is apparent. If fireproof brick floors are used the ceiling may also be formed of exposed brickwork.

Saving by Decorating Directly on the Brick:

16. In many buildings such as schools, and in much industrial work, it is possible to reduce the cost of the building by omitting the plaster and dull painting, enamelling, or decorating the interior directly upon the brick.

Exterior Walls:

17. Brick exterior walls are found in all city building ordinances as well as in the recommendations of insurance underwriters. The pilastered form of wall gives large window areas and furnishes support to the main girders of the floors where needed, or a flat wall may be used according to requirements. The former general type of construction may be carried out either in the form of curtain walls or panel walls at the choice of the designer.

Fire and Party Walls:

18. Buildings of large area should be divided into separate sections by fire walls, thus reducing the liability to one fire and giving an opportunity to place hazardous goods in one section and less hazardous goods in remaining sections.

Enclosures and Fire Towers:

19. Stairways, elevators and other shafts or openings extending from one floor to another should be enclosed in brick walls extending above the roof.

20. Fire towers should either be placed so that one side is formed by an exterior wall and provided with an outside balcony, accessible from each story on both sides of the tower; or the tower may be constructed within the building, connecting with an outside vestibule open to the weather, the vestibule having openings at each story closed with fire doors.

Fireproof Brick Floors:

21. The use of brick arch construction is worthy of the serious attention of architects and engineers for general floor construction and for vaults.

22. The brick arch floor is about the strongest type of floor arch for the span it occupies and the type shown in (a) Fig. 17 is probably the most fire-resistive of any system that can be employed.

23. There are two types of this floor, that shown by (a) Fig. 17 having the highest fire resistance, the flanges of the beams being protected by terra cotta skewbacks. Similar construction, but with exposed tie rods, is employed for the floors of the principal stories of the Government Printing Office at Washington, D. C.

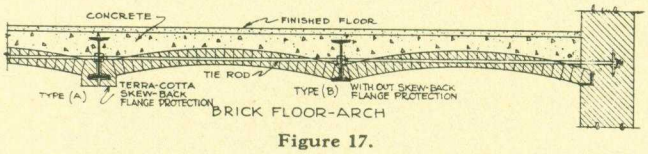


Figure 17.

24. Experiments show that brick arches will stand very severe pounding and a great deal of deflection without failure.

25. Arches need not be more than 4 in. thick for spans up to between 6 and 8 ft. (the most desirable span), if the haunches are filled with concrete level with the top of the arch. Tie rods should always be employed.

26. A 4 in. brick arch, 6 ft. span, well grouted and levelled off with concrete should safely carry 300 to 400 lbs. per sq. ft. The weight of this floor without the concrete fill is about 40 lb. per sq. ft. The ceiling so formed has all the neat and attractive appearance of brickwork and commends itself for industrial and other work.

27. A finished floor of cement, a wood floor on sleepers or a wood block or any other finished floor desired may be used.

28. To lay this floor in the most economical way the brick may be laid upon the centering touching each other at the soffit, the wedge shaped joints being filled with grout.

Tie Rods; Size and Spacing:

29. Tie rods are employed to prevent the beams being pushed apart, especially in the outer bays. They should run from beam to beam from one end of the floor to the other. If the outer arches spring from an angle as in Fig. 17, the tie rods in this bay should be anchored in the wall with large plate washers.

30. Rods should be located in the line of thrust, ordinarily below the half depth of the beams and in some cases near the bottom flanges. Arches should be designed, however, so that the rods will be protected from fire by keeping them above the soffit of the arches. This also gives a better appearance.

31. Rods are spaced generally in the proportion of eight times the depth of the supporting beams but never more than 8 ft. on centre. Their size should be proportioned to the horizontal thrust of the arches, this horizontal thrust being found as follows

$$T = \frac{3wl^2}{2R}$$

T = pressure or thrust in lbs. per lin. ft. of arch.

w = uniformly distributed load on arch in lbs. per sq. ft.

l = span of arch in feet.

R = rise of arch in inches.

The rise is measured from the spring line to the soffit in the middle.

32. Having found the thrust, the spacing of the rods of any particular size may be readily determined by dividing the safe load given for that size of rod in the table following, by the thrust. The result will be the spacing in feet.

TABLE 4
Safe Load in Pounds on Round Rods
Stress 16,000 lb. per sq. in.

Diameter Inches	Plain Rods Load in Pounds Based on Area at Root of Thread	Upset Rods Load in Pounds Based on Fuel Area of Rod
½	2 016	3 140
9/16	2 592	3 960
5/8	3 232	4 910
3/4	4 832	7 070
7/8	6 720	9 620
1	8 800	12 570
1⅛	11 104	15 900
1¼	14 288	19 630
1⅜	16 910	23 750
1½	20 720	28 270

33. Much of the data on the strength of fireproof brick floors and proportioning of tie rods is quoted from "Kidder's Architects and Builders' Handbook."

FIRE, PARTY, AND DIVISION WALLS SHOULD BE OF SOLID BRICK

Practical Experience and Laboratory Tests:

1. (See also fire tests on column coverings, pages 32-33.)

2. That brickwork is fire resistive to a remarkable degree is a fact attested by innumerable examples in which disastrous fires have spread and devastated property until they encountered structures built solidly with brick A brick chimney, standing alone and uninjured in the ashes of a burned home, is an ordinary sight in almost every village.

3. The writers of building codes, in creating fire zones in congested districts to make lives and property safer, find their chief ally against the spread of fire in good honest brick construction. Brick has proved itself fire resistive so often in actual experience that until recently no laboratory fire tests were ever made upon it. These tests amply show that the universal confidence felt in the fire resistiveness of brick has not been misplaced.

New Materials Should Pass Tests:

4. In view of the fact that priceless human lives and valuable property may depend upon the proper functioning of a wall built as a fire barrier, it is evident that code makers, architects and engineers should regard no new material as fire-resistive until those promoting it can produce actual test data from a reliable, disinterested authority of the highest

standing, such as the U. S. Bureau of Standards or the Underwriters' Laboratories, to substantiate their claims. The favorable opinion of a manufacturer or of any other person will not aid a fire wall in stopping the spread of fire and the issues at stake justify those who may be held responsible in being extremely conservative in this matter.

5. In the October, 1920 National Fire Protection Association Quarterly, C. E. Worthington says: "Walls of theoretically or generally proven insufficient character occasionally make phenomenal stops, and because these stops are unexpected they are widely advertised."

Definition of Party, Fire, and Division Walls:

6. **A party wall** is a separating wall between two buildings with different owners and occupants.

A fire wall is a vertical barrier dividing two or more parts of the same property from each other.

Division walls are walls separating buildings from each other, each being placed entirely on the property occupied by the building itself.

7. Walls in each of the above classifications should "have such stability as to remain intact after complete combustion of the contents of the building on either side of the wall; and its structural integrity shall be such as not to be dangerously impaired by the wreckage resulting from the fire or its extinguishment." (From discussion at the 1920 meeting of the National Fire Protection Association.) It was also agreed at the same meeting that a fire wall "shall have such thickness as to prevent the communication of fire by heat conduction."

National Board of Fire Underwriters Code:

8. The following is quoted from a note under "fire walls":

"The great value of solid walls in restricting the spread of fire is so well known, argument should be unnecessary to insure their use wherever suitable. A fireproof factory or warehouse with properly restricted areas between fire walls, equipped with automatic sprinklers, and having proper protection to vertical openings and windows, would be practically impossible to burn. The truth of this statement has been demonstrated many times. The folly of building otherwise is a self-evident verity.

TABLE 5

Height of Solid and Ideal Brickwork by Courses.

Based on Standard Brick 2¼" x 3¾" x 8"

Height from Bottom of Mortar Joint to Bottom of Mortar Joint

No. of Courses	⅜" Joints		½" Joints		⅝" Joints		¾" Joints	No. of Courses
	Brick Flat	Brick on Edge	Brick Flat	Brick on Edge	Brick Flat	Brick on Edge	Brick Flat	
1	2⅝"	4⅛"	2¾"	4¼"	2⅞"	4⅜"	3"	1
2	5¼"	8¼"	5½"	8½"	5¾"	8¾"	6"	2
3	7⅞"	1′— 0⅜"	8¼"	1′— 0¾"	8⅝"	1′— 1⅛"	9"	3
4	10½"	1′— 4½"	11"	1′— 5"	11½"	1′— 5½"	1′—0"	4
5	1′— 1⅛"	1′— 8⅜"	1′— 1¾"	1′— 9¼"	1′— 2⅜"	1′— 9⅞"	1′—3"	5
6	1′— 3⅝"	2′— 0¾"	1′— 4½"	2′— 1½"	1′— 5¼"	2′— 2¼"	1′—6"	6
7	1′— 6⅜"	2′— 4⅞"	1′— 7¼"	2′— 5¾"	1′— 8⅛"	2′— 6⅝"	1′—9"	7
8	1′— 9"	2′— 9"	1′—10"	2′—10"	1′—11"	2′—11"	2′—0"	8
9	1′—11⅝"	3′— 1⅛"	2′— 0¾"	3′— 2¼"	2′— 1⅞"	3′— 3⅜"	2′—3"	9
10	2′— 2¼"	3′— 5¼"	2′— 3½"	3′— 6½"	2′— 4¾"	3′— 7¾"	2′—6"	10
11	2′— 4⅞"	3′— 9⅜"	2′— 6¼"	3′—10¾"	2′— 7⅝"	4′— 0⅛"	2′—9"	11
12	2′— 7½"	4′— 1½"	2′— 9"	4′— 3"	2′—10½"	4′— 4½"	3′—0"	12
13	2′—10⅛"	4′— 5⅝"	2′—11¾"	4′— 7¼"	3′— 1⅜"	4′— 8⅞"	3′—3"	13
14	3′— 0¾"	4′— 9¾"	3′— 2½"	4′—11½"	3′— 4¼"	5′— 1¼"	3′—6"	14
15	3′— 3⅜"	5′— 1⅞"	3′— 5¼"	5′— 3¾"	3′— 7⅛"	5′— 5⅝"	3′—9"	15
16	3′— 6"	5′— 6"	3′— 8"	5′— 8"	3′—10"	5′—10"	4′—0"	16
17	3′— 8⅝"	5′—10⅛"	3′—10¾"	6′— 0¼"	4′— 0⅞"	6′— 2⅜"	4′—3"	17
18	3′—11¼"	6′— 2¼"	4′— 1½"	6′— 4½"	4′— 3¾"	6′— 6¾"	4′—6"	18
19	4′— 1⅞"	6′— 6⅜"	4′— 4¼"	6′— 8¾"	4′— 6⅝"	6′—11⅜"	4′—9"	19
20	4′— 4½"	6′—10⅛"	4′— 7"	7′— 1"	4′— 9½"	7′— 3½"	5′—0"	20
21	4′— 7⅛"	7′— 2⅝"	4′— 9¾"	7′— 5¼"	5′— 0⅜"	7′— 7⅞"	5′—3"	21
22	4′— 9¾"	7′— 6¾"	5′— 0½"	7′— 9½"	5′— 3¼"	8′— 0¼"	5′—6"	22
23	5′— 0⅜"	7′—10⅞"	5′— 3¼"	8′— 1¾"	5′— 6⅛"	8′— 4⅝"	5′—9"	23
24	5′— 3"	8′— 3"	5′— 6"	8′— 6"	5′— 9"	8′— 9"	6′—0"	24
25	5′— 5⅝"	8′— 7⅛"	5′— 8¾"	8′—10¼"	5′—11⅞"	9′— 1⅜"	6′—3"	25
26	5′— 8¼"	8′—11¼"	5′—11½"	9′— 2½"	6′— 2¾"	9′— 5¾"	6′—6"	26
27	5′—10⅞"	9′— 3⅜"	6′— 2¼"	9′— 6¾"	6′— 5⅝"	9′—10⅛"	6′—9"	27
28	6′— 1½"	9′— 7½"	6′— 5"	9′—11"	6′— 8½"	10′— 2½"	7′—0"	28
29	6′— 4⅛"	9′—11⅝"	6′— 7¾"	10′— 3¼"	6′—11⅜"	10′— 6⅞"	7′—3"	29
30	6′— 6¾"	10′— 3¾"	6′—10½"	10′— 7½"	7′— 2¼"	10′—11¼"	7′—6"	30
31	6′— 9⅜"	10′— 7⅞"	7′— 1¼"	10′—11¾"	7′— 5⅛"	11′— 3⅜"	7′—9"	31
32	7′— 0"	11′— 0"	7′— 4"	11′— 4"	7′— 8"	11′— 8"	8′—0"	32
33	7′— 2⅝"	11′— 4⅛"	7′— 6¾"	11′— 8¼"	7′—10⅞"	12′— 0⅜"	8′—3"	33
34	7′— 5¼"	11′— 8¼"	7′— 9½"	12′— 0½"	8′— 1¾"	12′— 4¾"	8′—6"	34
35	7′— 7⅞"	12′— 0⅜"	8′— 0¼"	12′— 4¾"	8′— 4⅝"	12′— 9⅛"	8′—9"	35
36	7′—10½"	12′— 4½"	8′— 3"	12′— 9"	8′— 7½"	13′— 1½"	9′—0"	36
37	8′— 1⅛"	12′— 8⅜"	8′— 5¾"	13′— 1¼"	8′—10⅜"	13′— 5⅞"	9′—3"	37
38	8′— 3¾"	13′— 0¾"	8′— 8½"	13′— 5½"	9′— 1¼"	13′—10¼"	9′—6"	38
39	8′— 6⅜"	13′— 4⅞"	8′—11¼"	13′— 9¾"	9′— 4⅛"	14′— 2⅝"	9′—9"	39
40	8′— 9"	13′— 9"	9′— 2"	14′— 2"	9′— 7"	14′— 7"	10′—0"	40
41	8′—11⅝"	14′— 1⅛"	9′— 4¾"	14′— 6¼"	9′— 9⅞"	14′—11⅜"	10′—3"	41
42	9′— 2¼"	14′— 5¼"	9′— 7½"	14′—10½"	10′— 0¾"	15′— 3¾"	10′—6"	42
43	9′— 4⅞"	14′— 9⅜"	9′—10¼"	15′— 2¾"	10′— 3⅝"	15′— 8⅛"	10′—9"	43
44	9′— 7½"	15′— 1½"	10′— 1"	15′— 7"	10′— 6½"	16′— 0½"	11′—0"	44
45	9′—10⅛"	15′— 5⅝"	10′— 3¾"	15′—11¼"	10′— 9⅜"	16′— 4⅞"	11′—3"	45
46	10′— 0¾"	15′— 9¾"	10′— 6½"	16′— 3½"	11′— 0¼"	16′— 9¼"	11′—6"	46
47	10′— 3⅜"	16′— 1⅞"	10′— 9¼"	16′— 7¾"	11′— 3⅛"	17′— 1⅜"	11′—9"	47
48	10′— 6"	16′— 6"	11′— 0"	17′— 0"	11′— 6"	17′— 6"	12′—0"	48
49	10′— 8⅝"	16′—10⅛"	11′— 2¾"	17′— 4¼"	11′— 8⅞"	17′—10⅜"	12′—3"	49
50	10′—11¼"	17′— 2¼"	11′— 5½"	17′— 8½"	11′—11¾"	18′— 2¾"	12′—6"	50
60	13′— 1½"	20′— 7½"	13′—10"	21′— 3"	14′— 4½"	21′—10½"	15′—0"	60
70	15′— 3¾"	24′— 0¾"	16′— 0½"	24′— 9½"	16′— 9¼"	25′— 6¼"	17′—6"	70
80	17′— 6"	27′— 6"	18′— 4"	28′— 4"	19′— 2"	29′— 2"	20′—0"	80
90	19′— 8¼"	30′—11¼"	20′— 7½"	31′—10½"	21′— 6¾"	32′— 9⅜"	22′—6"	90
100	21′—10½"	34′— 4½"	22′—11"	35′— 5"	23′—11⅝"	36′— 5½"	25′—0"	100

"Fire walls are as useful in protecting school buildings, hospitals, hotels, state and county buildings, large residence buildings, and in fact any building having considerable area, as they are in other types of buildings. In such public buildings where numerous people are housed, many of whom may be invalids or infirm, the life saving features of properly constructed fire exits through fire walls cannot be overestimated. The additional expense of such cutoffs is slight, and neither the architectural effects, nor the utility of the building, need be affected by their introduction. Necessary openings in such walls when not large, can be efficiently protected by fire doors as artistic in finish as ordinary doors."

Underwriters Favor Solid Brick:

9. That solid brick walls amply fulfill all the exacting requirements for walls of this class is indicated by the ratings of premiums on insurance policies. Throughout the country underwriters base these premiums at par on buildings with the solid wall and increase the premiums on any wall of hollow units.

10. This increase in premium, termed a "penalty" is a recurring tax not only on the valuation of the building but upon all its equipment and entire contents.

11. These rates are based upon the safety of the building; and the solid brick wall, which better protects the "risk" and enables it to remain after the fire as a "salvage" receives the most favorable or "base" rate.

12. Another consideration influencing "penalties" is the known certainty that with walls other than solid, water damage to adjoining properties, from seepage through the separating walls, cannot be guarded against.

Authorities Recommend Solid Brick:

13. For walls of this class, the solid brick wall is found in every building code of our cities, in the code recommended by the National Board of Fire Underwriters, and is recommended by all authorities on building construction and fire prevention.

14. Rudolph P. Miller, Superintendent of Buildings of the Borough of Manhattan, says:* "In the Baltimore and San Francisco fires it was demonstrated that for outside walls brick is superior as a fire proof material to any other material used in wall construction."

15. There are no disadvantages in solidity and safety.

Test Enclosures Built of Brick:

16. When subjecting other materials to fire tests the enclosure in which the tests are made is almost invariably built of brick, a fact which speaks for itself.

Brick Absorbs Sound:

17. Because of its unequalled capacity for absorbing sound, the solid brick wall is without a rival in this regard for party walls.

Brick Walls Preserve Owners' Rights:

18. Due to change of owners or occupants, increase of business, or enlargement of the building, it may be necessary to cut new openings in fire walls, enlarge existing openings or alter them in other ways. This can easily be done with a brick wall. (Page 8, par. 10.)

19. In the case of a party wall the foregoing advantage becomes a most important item. Each adjoining owner is entitled to the right of using the wall for his own requirements of construction. Without a wall which can be cut out at any desired height and at every required interval for the introduction of beams, joists, etc. or into which new chimneys and flues can be bonded or other changes made, one owner will be deprived of this right and be at considerable expense and lose valuable space as a result of having to build another wall; the other will lose his rebate of one-half the cost of the party wall as originally built.

20. So firmly is recognition of these facts entrenched as a right that in some states and many cities no other material than brick is permitted for party walls. In Philadelphia, for example, no material other than brick is used in the party walls of the four hundred thousand individual homes where such walls are used in that city. By an act of the State legislature, brick is specifically named as the one and only material which legally meets the requirements of a party wall.

*Kidder's "Architects and Builders' Handbook" page 814.

BRICK UNEXCELLED FOR SEWERS, SEPTIC TANKS AND MANHOLES

1. Sixty years ago the trunk sewers in the older section of Chicago were installed, all built of brick. For sixty years they have resisted the powerful acids found in sewage. Floods and torrents have done their worst and even now the old brick sewers are in good condition and in constant use.

2. This is but one instance of thousands where brick has proved the ideal material for all places where the action of acids inside and outside the structure must be resisted.

3. Brick sewers are very economical to install, even large circular trunk sewers being built without centering or form-work of any kind.

4. For more detailed information on the proper material for sewers, write to the Common Brick Manufacturers' Association, 2121 Discount Bldg., Cleveland, Ohio, for free pamphlet "Did you ever see the inside of a sewer?"

PROPERTIES OF BRICK AND BRICKWORK

COMPRESSIVE STRENGTH OF BRICKWORK

Safe Working Stresses for Brickwork:

1. Many more tests must be made and much more investigational work must be done before exact formulas can be worked out whereby engineers can take advantage to the full of the enormous strength of brickwork.

2. Until such work is completed, the reader is referred to the numerous standard text books which give the usual but inadequate allowable stresses on brick piers and walls. The Architects' and Builders' Pocket Book, by Kidder-Nolan, the Hool and Johnson Handbook of Building Construction, and others might be mentioned.

Present Practice too Conservative:

3. An inspection of the test results given makes it evident that present practice and code requirements for designing brickwork are much too conservative, resulting in piers and walls that are not only wasteful in material but which take up more room than necessary. This militates against the use of brickwork in places where the certainty of its strength and integrity of its construction would make it the preferred material.

4. Prof. Ira O. Baker* states "It would seem that reasonably good brick laid in good lime mortar should be safe under a pressure of 20 tons per sq. ft., and that the best brick in good Portland cement mortar should be safe under 30 tons per sq. ft."

5. To supply exact engineering data upon which accurate formulas may be based is one of the important functions of a trade association. The Common Brick Manufacturers' Association is a comparatively new organization, having had a paid staff only since 1919. Investigations regarding the properties of brickwork, particularly with regard to the relation of the strength of individual bricks to that of walls and piers, which will be conducted jointly by the Association and the U. S. Bureau of Standards and other bodies, will undoubtedly enable engineers to take fullest advantage of the great strength of brickwork and use much higher stresses and smaller sections.

Brick the Strongest Masonry:

6. An inspection of the test results in which the strength of mortar specimens is given with the strength of the resultant brickwork brings to light the following interesting fact. Using almost any brick above the grade of underburned brick, the strength of brick piers and walls almost invariably exceeds that of cubes of mortar in which the brick is laid.

7. An instance of this is shown in the results of the University of Illinois brick pier tests (Table 13, page 32), in which 1:3 cement mortar and other mortars were used. A 1:3 proportion is a much richer mix than ordinarily used in poured construction.

8. The strength of some of the brick piers and walls of which test results are here given compares very favorably with reinforced piers and walls of concrete construction.

9. To obtain the strongest masonry, therefore, use good brick (laid on edge if permissible), strong yet plastic mortar, keep the joints thin and bed the brick as evenly as possible.

Description of Tests, General:

10. The purpose of tests is to determine what force is ultimately required to destroy any particular type of construction.

11. Although numerous compression tests have been made in the past on brick piers, no brick walls have been tested until recently, to the knowledge of the author, by any reliable disinterested authority. We believe that there is only one crushing machine in existence capable of testing to destruction even an eight inch wall of average story height and long enough to give true wall action.

12. Compression and transverse tests upon representative single bricks and small cubs of the mortar used in the structure are generally made to arrive at a ratio between the strength of the constituent parts of the wall and the finished panel.

13. The tensile strength of individual brick will also be determined in many future tests. For this purpose small briquettes are shaped in moulds similar to those used for making cement briquettes, and after being burned, are tested in a similar manner.

Brick and Imitation Brick:

14. Brick are always burned. There are now on the market imitation brick which are not burned and which have only a fraction of the strength, weather resistiveness and fire resistiveness of real brick. A wall surface of imitation brick has a cold and unsatisfactory appearance even when artificially colored. Well burned brick has a beautiful everlasting surface which time itself seems powerless to destroy.

Strength of Clay Brick Before Burned:

15. Burning greatly hardens and strengthens the shapes of clay but even before burning they will bear enormous loads. "Green" brick are stacked in the kilns on edge, the piles often being twenty feet or more high. In spite of the enormous weight of wet clay which the bricks in the lower portion of the kiln have to bear, this load does not even press them out of shape. This is more remarkable when it is remembered that the brick cannot support each other laterally, being set a slight distance apart to permit the fire passing between them.

Strength of Individual Brick:

16. That brick has almost incredible strength is fully borne out by the following table. Attention is

* "A Treatise on Masonry Construction" page 167.

TABLE 6

Compressive Strength of Individual Brick Tested Flat.

Brick	No. of Tests	Transverse Strength. Pounds per Sq. In. Modulus of Rupture	Pounds per Sq. In. Ultimate Crushing Strength	Tons per Sq. Ft. Ultimate Crushing Strength
ARKANSAS				
(a) Red. Grade 1	3		13,253	953
(a) Red. Grade 2	3		11,966	860
(a) Red. Grade 3	3		5,620	406
D. C.				
(b) Red	5		7,370	530
(b) Arch	3		8,230	592
(b) Press	4		7,092	511
ILLINOIS				
Representative brick from Chicago district.				
(c) Hard burned		1,180	3,200	231
(c) Medium burned		1,140	3,150	226
CENTRAL ILLINOIS				
(d) Shale building brick	18	1670	10,690	770
(d) Underburned common	16	481	3,920	282
IOWA				
(e) Hard burned common	4		9,522	685
(f) Common	6	660	3,370	243
(f) Soft or salmon	3	300	1,850	133
KANSAS				
(e) "Red brick"	4		9,432	679
KENTUCKY				
(e) Dark gray	1		20,030	1,442
(e) Gray	1		16,793	1,210
(e) Dark cream	6		7,243	521
(e) Red	7		5,290	380
LOUISIANA				
Representative brick from New Orleans district				
(c) Hard burned		733	7,340	528
(c) Medium burned		893	6,880	496
(c) Soft burned		1,090	6,510	468
MARYLAND				
(e) "Dark cream"	3		6,424	463
(e) Red	2		4,922	354
(e) Light red	3		3,266	235
MASSACHUSETTS				
(g) Hard burned common	23		12,907	929
(h) Medium burned common	3		11,073	797
(i) Light hard common	15		5,682	409
MISSISSIPPI				
(a) "Light red building brick"	3		7,573	545
MISSOURI				
(e) St. Louis "dark red"	5		22,976	1,654
NEW YORK				
(a) Northern N. Y. "dark brown building brick"	3		26,763	1,926
Representative brick from New York district				
(c) Hard burned		601	5,630	405
(c) Medium burned		616	4,430	319
(c) Soft burned		497	2,710	195
NORTH CAROLINA				
(e) Red common	7		5,307	382
(e) Light red common	4		3,662	264
PENNSYLVANIA				
Representative brick from Pittsburgh district				
(c) Hard burned	12	1,945	11,965	861
(c) Medium burned		1,370	7,880	567
(c) Soft burned		345	1,659	119
WASHINGTON				
(e) "Buff colored building brick"	4		4,560	328
(e) "Light buff building brick"	6		2,987	215
(e) "Cream colored building brick"	6		4,066	292
WYOMING				
(e) "Light red light hard"	3		3,450	248
(e) "Rose colored"	3		2,290	165

(a) Tests of metals, etc., Watertown Arsenal, 1908.
(b) Tests of Metals, etc., Watertown Arsenal, 1884.
(c) Bureau of Standards, Technologic Paper No. 111, 1918.
(d) University of Illinois, Bulletin 27, 1909.
(e) Tests of Metals, Watertown Arsenal, 1906.
(f) Iowa State College Bulletin 6, 1908.
(g) Average of 3 tests in 1884; 15 tests in 1904; and 5 tests in 1907, Watertown Arsenal.
(h) Tests of Metals, etc., Watertown Arsenal, 1884.
(i) Average of 10 tests in 1904 and 5 tests in 1907, Watertown Arsenal.

directed to the strength of soft burned brick, which is well adapted for use in backing or interior partitions. Unfortunately, the classification of many of the brick in the table adjoining is very indefinite.

Individual Brick and Brickwork, Relative Strength:

17. Factors influencing the strength of brickwork are: (a) strength of individual brick; (b) strength of mortar; (c) bond of brickwork; (d) relation of length and thickness of wall or pier to unsupported height.

18. A sufficiently close ratio has not yet been established between the strength of individual brick and of brickwork. The strength of the latter is proportionate to both the compressive and transverse strength (modulus of rupture) of the bricks, although recent tests indicate that the strength of brickwork may be in closer proportion to the transverse than to the compressive strength of the units.

19. Possibly the strength of brickwork may bear a closer relation to the tensile strength of the brick units rather than to their transverse or compressive strength.

Strength of Bonds in Piers:

20. The material under this and the following heading is quoted, in substance, from U. S. Bureau of Standards Technologic Paper III, Tests of Large Brick Piers.

21. The opinion prevails that the tying in of masonry with header courses helps to strengthen piers against bulging action, thereby increasing the strength in proportion to the number of headers used. Results obtained in recent tests of brick piers, however, show that variations in the number of header courses used do not have a positive effect on the compressive strength of the pier. (See also strength of bond in walls, pars. 5-6, page 42.)

Brick on Edge, Strength:

22. When tested to destruction a pier fails by vertical cleavage, little crushing of the bricks being apparent; this being due to the unequal loading of the individual brick as the pier is compressed. It follows, therefore, that any method of construction which would increase the depth of the brick courses or the component parts of the pier would increase its strength. In the Watertown Arsenal tests, this was done by laying the bricks on edge; also by breaking joints every sixth course when laid flatwise and every third course when laid on edge.

23. In these tests face brick were laid in 1:1 cement mortar. The following table shows the gain in strength (which would probably be greater for softer mortars):

TABLE 7

Percentage Gain in Strength by Various Methods of Laying Brick.

Method of Laying Brick	Percentage Gain in Strength
BRICKS FLAT:	
Joints broken every course	0
Joints broken every sixth course	7.2
BRICKS ON EDGE:	
Joints broken every course	43.6
Joints broken every third course	57.1

24. The following is a record of the above mentioned Watertown Arsenal tests:*

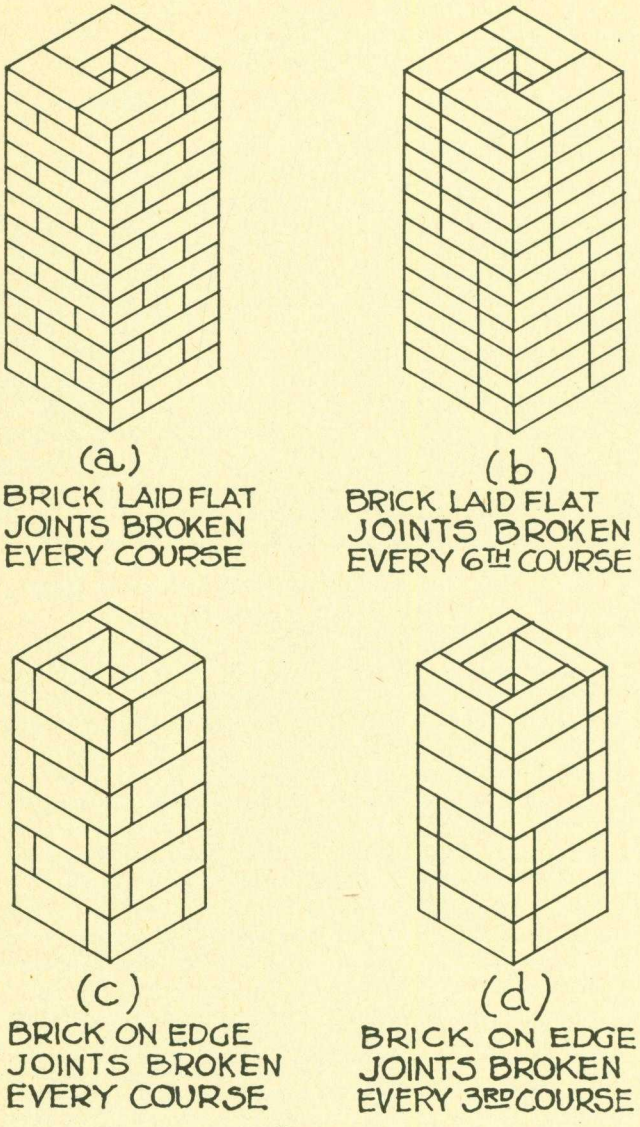


Figure 18.

TABLE 8
Comparative Strength of Brick Piers with Brick Laid Flat and on Edge.
Brick Piers, 8 ft. High. Laid in 1:1 Portland Cement Mortar

Reference No.	Size of Pier	Pier, How Laid	Age	Tons Ultimate Compressive Strength of Pier	Pounds Ultimate Compressive Strength of Pier	Unit Strength of Pier Pounds per Sq. In. Net Area
1	12"x12"	Brick flat Hollow core, Joints broken every course. (a) Fig. 18.	2 Mo. 16 Da.	216.5	433,000	3,217
2	12"x12"	Brick flat Hollow core, Joints broken every 6th course. (b) Fig. 18.	2 Mo. 21 Da.	231.5	463,000	3,451
3	11"x11"	Brick on edge, Hollow core, Joints broken every course. (c) Fig. 18.	2 Mo. 21 Da.	181.75	363,500	4,622
4	11"x11"	Brick on edge, Hollow Core, Joints broken every 3rd course. (d) Fig. 18.	2 Mo. 16 Da.	190.5	381,000	5,055

Tests of Metals, etc., Vol. for 1907.

Use of Brick on Edge Piers:

25. The attention of designers is especially directed to the above tests, the use of brick on edge offering an opportunity for strengthening brick piers without increasing their area. Projecting pilasters may sometimes be avoided by laying short lengths of wall of hollow or solid brick work on edge where concentrated loads occur.

26. If brick on edge piers are built hollow, some method should be employed to hold brick units in place in case of severe fire. This may consist of a stout wire laid in the mortar joints of each or alternate courses. The wire should be continuous around the pier with ends lapping well over each other. (Par. 10 and par. 17, page 33.)

27. It is to be specially noted that the courses of brick on edge piers line with the courses in Ideal walls, thereby making it convenient and easy to bond Ideal wall construction to piers of brick on edge.

Strength of Mortar:

28. Tests at Columbia University by Prof. Macgregor* indicate that while cubes of cement mortar are stronger than cubes of cement-lime mortar, brickwork laid in cement-lime mortar,—using a 1:1:6 mixture,—is stronger than when a straight 1:3 cement mortar is used, this being attributed to the increased plasticity given by the lime, resulting in a more thorough bedding of the brick and more complete filling of the joints, calling into play less of the transverse strength of the brick units. This is also borne out by Kreuger's tests, the relative strength of mortar and completed piers 4 and 5 being noted. Table 10.

29. Tests made later by the Bureau of Standards do not entirely corroborate the above results, probably due to the fact that in the latter case the piers tested were larger, being 30"x30", as against 8"x8" in the Columbia University tests. The Bureau of Standards tests showed practically no difference in the strength of straight 1:3 Portland cement mortar and similar mortar in which 35% by volume of cement was replaced by lime.

30. Cement-lime mortar is cheaper and saves bricklayers' time because of its greater plasticity.

31. Lime mortar, while naturally weaker than cement or cement-lime mortar, produces brickwork strong enough for many purposes.

Krueger's Tests:**

32. Investigations were made in 1916 by Prof. H. Krueger at the Technical High School in Stockholm, conducted on small piers. Laid in lime mortar, the piers developed 18.5 to 26.5 of the ultimate compressive strength of the brick units, which latter were of various strengths.

33. The compressive strength of the individual bricks was arrived at in a different manner to that employed on this continent, however, halves of the same brick being cemented together and the two courses compressed. Compressive strength developed in this manner would be lower than in the case of a single half brick tested flat and the relative efficiency of the pier would be higher; so that these test results cannot be compared with results of tests made in this country.

*Bulletin J. National Lime Association.
**Technologic Paper No. III Bureau of Standards.

TABLE 9
Influence of the Strength of Brick on Piers.
(Mortar: 1 lime, 3 sand. Age, 28 days)

Number of piers Tested	Height of Piers	Breadth of Piers	Average Compressive Strength of		Per Cent Compressive Strength of Bricks Developed in Piers		
			Brick Used	Piers	Minimum	Maximum	Average
	Inches	Inches	Lbs./in.²	Lbs./in.²			
5	34.0	10.0	1920	410	19.3	23.7	21.3
4	34.0	9.5	2510	670	23.7	29.5	26.5
3	33.0	9.5	4040	880	20.0	24.3	21.8
5	33.5	9.5	5300	980	15.0	21.2	18.5
4	31.0	9.5	7120	1820	24.7	26.2	25.5
5	30.5	9.0	8600	1680	17.5	21.6	19.5

TABLE 10
Influence of the Strength of Mortar on Piers
(Mortar: 1 lime, 3 sand. Age, 28 days)

Pier No.	Compressive Strength of		Mortar Mixture	Compressive Strength of Piers
	Bricks	Mortar		
	Lbs./in.²	Lbs./in.²		Lbs./in.²
1	4040	0	Dry sand	740
2	4040	38	1 lime; 3 sand	740
3	4040	355	2 lime; 1 cement; 9 sand	1420
4	4040	695	1 lime; 1 cement; 6 sand	1840
5	4040	1280	1 lime; 2 cement; 9 sand	1700
6	4040	1640	2 lime; 1 cement; 7 sand	1930
7	4040	2620	1 cement; 3 sand	1980

TABLE 11.
Influence of Varying the Height of Piers.
(Mortar: 1 lime, 3 sand)

Pier No.	Compressive Strength of Bricks	Breadth of Pier	Ratio, Height to Breadth	Compressive Strength of Piers
	Lbs./in.²	Inches		Lbs./in.²
1	3260	10.6	4.3	2340
2	3260	10.6	8.7	2320
3	3260	10.6	13.0	1940
4	3260	10.6	17.4	1620
5	3260	10.6	21.7	1090
6	3260	10.6	26.4	1020
7	3260	10.6	30.7	Broken
8	3260	10.6	35.4	780
9	3260	10.6	39.5	880
10	3260	10.6	43.4	880
11	3260	10.6	48.8	750
12	3260	10.6	53.2	780
13	3260	10.6	57.5	640
14	3260	10.6	61.8	610
15	3260	10.6	65.8	660
16	3260	10.6	69.7	660
17	3260	10.6	74.5	610
18	3260	10.6	78.8	610

TABLE 12.
Effect of Eccentric Loading of Piers.
(Mortar: 1 lime, 3 sand)

Height of Pier	Breadth of Pier	Compressive Strength of Brick	Compressive Strength of Mortar	Maximum Load	
				Concentric Load	Eccentric Load
Inches	Inches	Lbs./in.²	Lbs./in.²	Lbs./in.²	Lbs./in.²
33	9.4	4040	50	890	417
33	9.4	5600	50	1220	570
31	9.4	7100	50	1850	850

U. S. Government Tests:*

34. A valuable series of tests on brick piers were made by the U. S. Government at Watertown Arsenal from 1884 to 1907.

35. Thirty-three piers, tested in 1884, showed an ultimate compressive strength of from 6 to 16 per cent of the individual brick, the brick being extremely hard burned. Piers were from 8″x8″ to 16″x16″ and from 16 in. to 10 ft. high.

36. Fifty-three piers tested in 1886, laid in 1:2 natural cement mortar, developed an ultimate strength of from 18 per cent of the individual brick in a column three diameters long to 12½ per cent in a column 15 diameters long. One column tested contained no mortar, and yet a load of 525 lbs. per sq. in. or 37.8 tons per sq. ft. was necessary to crush it.

37. Twenty-six piers were tested in 1904. The piers were 12″ x 12″ x 8 ft., the variations being in the brick, mortar and the age. The individual brick varied from 4470 lbs. per sq. in. or 322 tons per sq. ft. to 12,700 lbs. per sq. in. or 915 tons per sq. ft.in ultimate compressive strength. In neat cement mortar one column developed an ultimate strength of 4,700 lbs. per sq. in. or 338 tons per sq. ft.; another with the same mortar but poorer brick about 2000 lbs. per sq. in. or 144 tons per sq. ft. Ratio of ultimate strength of piers to ultimate strength of individual brick were: In neat Portland cement mortar, range 23 to 43 per cent., average 30 per cent.; 1:3 Portland cement mortar, 16 to 35 per cent., average 24 per cent.; 1:3 lime mortar, 9 to 18 per cent., average 13 per cent.

38. Thirteen brick piers were tested in 1905, the piers being 12″x12″x8 ft. high, laid with 8 varieties of brick laid in neat Portland cement mortar, cement mortar, and lime mortar, and tested when about 5 months old. The ultimate values ranged up to 4552 lbs. per sq. in. or 328 tons per sq. ft. in neat Portland cement mortar. Those laid in 1-3 mortar gave ultimate values up to 3422 lbs. per sq. in. or 246 tons per sq. ft. No tests of individual brick were given.

39. Fifteen piers were tested in 1906. Piers were 12″x12″x8 ft., laid in neat Portland cement mortar 1:3, 1:5, and 1:7 Portland cement mortar, 1:3 lime and 1 cement to 1 lime mortar. Tests were made at about eight months. The results ranged from 853 lbs. per sq. in. or 61.4 tons per sq. ft. to 3437 lbs. per sq. in. or 247 tons per sq. ft., ultimate strength. With the same brick, nearly identical values were found by using 1:7 Portland cement mortar and 1:1 lime mortar.

40. Thirty-two piers were tested in 1907, the most interesting feature of which is tabulated in Table 8, page 30.

41. Seventeen piers were tested at the School of Practical Science, Toronto, in 1895-6. Piers were 9″x9″ and from 21 to 73 in. high. Eleven grades of brick in 1:2 lime mortar and 1:3 cement mortar were used. Of the piers loaded to failure 11 laid in lime mortar gave ultimate values averaging 16 per cent. of the ultimate strength of the individual brick, while 5 laid in cement mortar averaged 46 per cent. of the ultimate strength of the brick.

University of Illinois Tests:*

42. Fourteen piers of shale brick and 2 piers of underburned brick were tested in 1908 by A. N. Talbot and D. A. Abrams, the results of which are here tabulated.

43. Special attention is drawn to the heavy load sustained by the piers(D) which were purposely laid in a careless and hurried manner, showing conclusively that with brick construction the human factor is reduced to a minimum. Good workmanship is, of course, necessary to produce good brick work, but the danger of failure on account of poor workmanship is small.

44. Note also the great strength of brick under eccentric load.

45. The enormous bearing capacity of piers laid with soft or underburned brick should also be observed.

*Results of Watertown Arsenal tests and School of Practical Science tests are quoted in substance from digest given in Bulletin 27 University of Illinois.

*Bulletin 27 University of Illinois.

TABLE 13
Summary of Tests of Brick Columns.
University of Illinois
Average Values
Size of Columns 12½"x12½"; 10 ft. long
By A. N. Talbot and D. A. Abrams

Ref.	Number of Specimens Tested	Characteristics of Columns	Tons per sq. ft. Average Ultimate Unit Strength	Lbs. per sq. in. Average Ultimate Unit Strength	Ratio of Ultimate Strength of Column to Ultimate Strength of Brick	Ultimate Crushing Strength of 6-in. Mortar Cubes, lb. per sq. in.	Ratio of Ultimate Strength of Column to Ultimate Strength of Cubes
		SHALE BUILDING BRICK					
		Ultimate Compressive Strength of Individual Brick 10,690 lb. sq. in. or 769 tons per sq. ft.					
A	3	Well laid, 1-3 Portland cement mortar, 67 days	242	3365	.31	2870*	1.17
B	2	Well laid, 1-3 Portland cement mortar, 6 months	284	3950	.37	.....	.....
C	2	Well laid, 1-3 Portland cement mortar, eccentrically loaded, 68 days	201	2800	.26	.....	.....
D	2	Poorly laid, 1-3 Portland cement mortar, 67 days	210	2920	.27	2870*	1.05
E	2	Well laid, 1-5 Portland cement mortar, 65 days	160	2225	.21	1710	1.30
F	1	Well laid, 1-3 natural cement mortar, 67 days	126	1750	.16	305	5.75
G	2	Well laid, 1-2 lime mortar, 66 days	104	1450	.14	.....	.....
		UNDERBURNED CLAY BRICK					
		Compressive Strength of Individual Brick 3,920 lb. per sq. in. or 282 tons per sq. ft.					
H	2	Well laid, 1-3 Portland cement mortar, 63 days	76	1060	.27	2870*	.37

*Average value based on 13 tests of 1-3 Portland cement mortar cubes 60 days old

University of Illinois Concrete Tests:*

46. It is interesting to compare the results of tests on concrete columns, made by A. N. Talbot, with those of brick columns scheduled above. Taking the average ultimate strength it will be noted that plain columns of 1:2:4 concrete have only about one-half the ultimate strength of piers the same age of well burned brick in 1:3 Portland cement mortar and also show much less strength than even the carelessly laid brick piers. Compare also with results given in Table 8. page 30.

*Bulletin 21 University of Illinois.

TABLE 14
Tests of Plain Concrete Columns.
University of Illinois
Materials: Portland cement, Wabash River sand, crushed limestone. Columns, 12 in. diameter, round, 10 ft. long.
By Arthur N. Talbot

Number of Specimens Tested	Proportions of Concrete	Average Age days	Average Ultimate Unit Strength lb. per sq. in.	Maximum Ultimate Unit Strength lb. per sq. in.	Variation in Per Cent from Average %	Minimum Ultimate Unit Strength lb. per sq. in.	Variation in Per Cent from Average %
2	1:1½:3	64	2 300	2 480	8	2 120	— 8
7	1:2:4	65	1 740	2 210	27	1 165	—33
2	1:3:6	61½	1 033	1 110	7	955	— 7
2	1:4:8	63	575	575		575	
7	1:2:4	206	1 944	2 680	38	1 460	—25
2	1:2:3¾	14 mo	2 710	2 770	2	2 650	— 2

U. S. Bureau of Standards Tests:

47. Some of the most valuable tests yet conducted were made upon fifty large brick piers in 1917 by the U. S. Bureau of Standards. The most important conclusions drawn were the following:

a. That primary failure of piers is caused by transverse failure of individual bricks.

b. The ultimate strength of the pier may be increased by any method of construction which increases the depth of the component parts of the pier. Laying bricks on edge instead of flat; breaking joints very few courses instead of every course; or using brick of more than ordinary thickness are methods that will produce this result. This bears out conclusions drawn from the Watertown Arsenal tests, previously quoted (Pages 29-30, pars. 22-27.)

c. The ultimate strength of brick piers is proportional to the compressive and transverse strength of the bricks.

48. A full report of these tests may be found in Technologic Paper No. III, obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C.

FIRE-RESISTIVENESS OF COLUMN COVERINGS

Underwriters Tests:*

1. The most exhaustive fire tests ever made upon structural materials have been recently conducted jointly by the Associated Factory Mutual Fire Insurance Companies, the National Board of Fire Underwriters and the U. S. Bureau of Standards. Eight years, 1910-1918, were consumed in making these tests and the report was issued in December, 1920.

2. At the time the tests were made the common brick industry was unorganized, so that co-operation was impossible and the brick industry had no representative to suggest further tests upon its material. Only one test was made with brick laid in the ordinary way and one test with brick laid on edge.

3. The test columns consisted of steel columns under load protected by various thicknesses of materials.

4. Only test results of brick and of the unfilled hollow clay tile protection upon which its fire resistance period is based are given here.

5. The test column was in each case 12 ft. 8 in. high.

6. The following were the outside dimensions of the hollow tile coverings. Test 48, 13½ in. square; test 49, 17½ in. square. Outside dimensions of the brick coverings were: Test 68, 13¼ in. square; test 69, 16½ in. square.

7. The mortar used for both hollow tile and brick consisted of 1 part by loose volume of Portland cement, 1 part lime putty and 4 parts fine beach or bank sand.

8. The brick in test 68 were laid on edge, the total thickness of protection being 2¼". In test 69 the brick were laid flat, the thickness of the protection being 3¾". Material under the following headings marked thus "*" is taken direct from the volume previously referred to.

*From "Fire Tests of Building Columns" published by the Underwriters' Laboratories, 207 East Ohio Street, Chicago, Ill.

TABLE 15

Results of Fire Tests on Column Coverings.

Columns Protected by Unfilled Hollow Clay Tile

Test No.	Section	Protection: Thickness of Tile, In.	Protection: Kind of Tile, Filling, and Method of Tying	Age of Covering, Days	Load Sustained During Test, Lb.	Time to Failure, Hr./Min.	Furnace Exposure Per Cent
48	Rolled H	2	New Jersey semi-fire clay no filling Outside wire ties.	496	119500	1/50	100.9
49	Rolled H	4	Same as No. 48	497	119500	1/40	99.9

Columns Protected by Brick.

Test No.	Section	Thickness of Brick, In.	Kind of Brick and Filling	Age of Covering, Days,	Load Sustained During Test, Lb.	Time to Failure, Hr./Min.	Furnace Exposure, Per Cent
69	Rolled H	3¾	Chicago common brick laid flat, Brick fill	502	119500	7/13¼	101.2
68	Rolled H	2¼	Chicago common brick set on edge, and end, Brick fill	498	119500	1/40¾	104.0

***Discussion of Test Results of Brick.**

9. "In No. 69 with the brick laid flat, little cracking or spalling developed before failure. Fusion of the brick began between the fourth and fifth test hours, and after test the brick was found fluxed away to a depth of about one-half inch. The uniform temperature rise in the metal indicates that the fusion of the brick did not contribute greatly to the failure of the column, the same being evidently caused by normal transmission of heat through the covering.

10. "In No. 68 where the brick was set on edge and end, the lack of stability considerably shortened the test, a large amount of brick falling during the first 30 min."

***Fire Resistance Period, How Derived**

11. "A given resistance period is taken to hold, if the time to failure in the fire test, or the average of the time to failure in a group of similar tests, is equal to one and one-half times the given resistance period. The deduction of one-third of the test duration is made to allow for incidental variations in material and workmanship of columns and coverings, and differences in load and fire conditions that cause variations in results with nominally comparable columns."

***Fire Resistance Period, Unfilled Hollow Tile Protection**

12. "Structural steel columns with hollow clay protections of 2-in., 3-in. or 4-in. semi-fire clay tile of medium hardness, tied with outside wire ties, give **one hour** fire resistance.

"This period is based on results of fire test Nos. 48 and 49 taken together with fire and water tests Nos. 105 and 107. The tile in these tests developed fewer disruptive effects on exposure to fire than any other kind tested. Tile more sensitive to abrupt temperature change is not adapted for use in unfilled protections, as the cracking and spalling resulting after a short fire exposure allows the heat to readily reach the steel, also on application of water, parts of the impaired covering are liable to be carried away, leaving the metal unprotected against a possible recurring fire.

13. "The use of unfilled protections should generally be avoided as the filling materially increases their stability and insulating value."

***Fire Resistance Period, Brick Protection:**

14. "Structural steel columns protected with common surface clay brick laid flat on side to form a solid protection of about four inch thickness, develop **5-hour** fire resistance, and with brick set on edge and end outside of the flanges and edges, and filling the whole space to the steel, **one-hour** fire resistance is developed."

Fire Resistance Period Necessary to Qualify:

15. To qualify as fire resistive, it is generally considered that any material must be given at least a four hour rating.

Brick on Edge Column Protection:

16. The brick on edge in this test were not held in place by anything except the bond of the brick at the corners of the pier.

17. It is the belief of the author that if a tie wire were placed in each or alternate horizontal courses, extending in one piece around the column and lapping over at the ends, that 2¼" brick on edge column protection would fulfill the requirements for a four hour rating.

HEAT EXPANDS BRICK LEAST

1. From the following table below it will be noted that brick masonry expands less under heat than any other type of masonry, a fact which should be taken into account when selecting the materials for fire resistive walls, for with less expansion there is less chance for buckling at high temperatures.

2. To find the increase of a bar due to an increase in temperature from the table, multiply the length of the bar by the increase of degrees and by the coefficient for 100 degrees, and divide by 100.

TABLE 16

†Coefficients of Expansion of Various Materials.

For 100 Degrees

Substance	Linear Expansion: Centigrade	Linear Expansion: Fahrenheit
Ashlar masonry	.00063	.00035
Brick masonry	.00055	.00031
Cement, Portland	.00107	.00059
Concrete	.00143	.00079
Concrete masonry	.00120	.00067
Granite	.00084	.00047
Limestone	.00080	.00044
Marble	.00100	.00056
Plaster	.00166	.00092
Rubble masonry	.00063	.00035
Sandstone	.00110	.00061
Slate	.00104	.00058

†Pocket Companion, Carnegie Steel Co., Page 377.

MATERIALS USED IN BRICK CONSTRUCTION

BRICK

Definition:

1. A brick is a solid building unit of burned clay.

2. **Common brick** has a natural surface, in distinction to **face brick,** in which the face is roughened or otherwise treated to produce special effects in texture or color.

Brick Clay:

3. Brick is made from an argillaceous earth, purified and refined by nature by processes extending over millions of years. The raw material has passed through tests such as we can hardly dream of in this age. Brick clay has successfully withstood great convulsions of nature, terrific heat and glacial action, and has amply proved itself to be practically indestructible. The action of fire upon solid shapes of clay moulded into brick form increases, if possible, this quality of indestructibility. Modern villages built near the ancient city of Babylon are constructed from bricks found in its ruins, dating back several thousand years B. C.

4. Most brick are made from surface clay, dug by steam shovels or by hand from open clay pits. Other brick are made from incipient shales which are often mined.

Methods of Brickmaking:

5. There are many methods of preparing the clay; of forming the shapes; and in methods of burning. The process followed in each locality depends on the characteristics of the clay and kind of brick desired.

6. **Pressed brick** are made by the dry press or repressed method. Pressed brick have a fine smooth surface with true angles and corners.

7. **Dry press** brick are made by pressing practically dry granulated clay into moulds under terrific pressure. Pressed bricks were formerly set in kilns without further drying, and burned.

8 **Re-pressed brick** are first pressed as described for dry pressed brick, but the moulds are a little larger. The brick are then dried and pressed again into smaller moulds before being burned.

9. **Soft mud** brick are divided into two classes—**sand mould** and **water struck.** The clay is mixed with water and pressed into moulds, the excess clay being struck off level with the top of the mould. To prevent the wet clay adhering to the mould, either the latter is dashed with sand—producing **sand mold** brick; or the mould is wet—producing **water struck** brick. The brick are then dried, either in the open air or in special dryers and set in the kiln.

10. **Stiff mud** brick are divided into two classes—**end cut** and **side cut.** They are made from stiff clay forced through a rectangular die, issuing in the form of a continuous bar, cut off to proper length by wire cutters. If the clay bar has the cross section of the width and thickness of a brick the wire cuts the bar to the proper **length** (end cut brick). If the clay bar has the section of the width and length of a brick the wire cuts the bar to the proper **thickness** (side cut brick.) The brick are dried in the same manner as soft mud brick.

11. All brick are burned, being exposed for several days to terrific heat—the temperature of a kiln averaging about 2000 degrees Farenheit.

Visit a Brick Plant:

12. Although improved methods of manufacture have been introduced within recent years, the basic principle is the same as that handed down through the centuries, a valued heritage from antiquity.

13. There are few processes so interesting to the architect, engineer, builder and technical student, and few that will so well repay a visit by developing a better understanding of the various grades of a local and easily available product. Brickyards are easily accessible in every part of the country and visitors to plants of members of the Common Brick Manufacturers' Association are always welcome.

Size of Brick:

14. The standard size of all building brick—face and common—is 8″x2¼″x3¾″. It is understood that a reasonable variation is allowed, for clay generally shrinks in the process of burning, and brick from the middle or hottest part of some kilns may be ⅛″ to 3/16″ shorter in length than brick from the outside or cooler portion of the same kiln.

Color of Brick:

15. Owing to differences in the chemical composition of clay, the color of brick varies considerably in different parts of the country; oxide of iron and lime being the chief factors which influence it.

16. To a lesser extent the degree of heat to which the bricks are subjected while burning also affects the color, but the presence or absence of any particular color is not always indicative of their hardness. Any good mechanic will lay only the hardest bricks to the weather.

Weight of Brick:

17. This varies greatly with the clay. The average common brick of standard size weighs, however, about 4½ lbs. For average weight of laid brickwork for solid walls see Table 1, page 9; and for Ideal walls, Tables 23 and 24, page 69.

Bulk of Loose Brick:

18. One thousand brick closely stacked occupy about 56 cu. ft. of space.

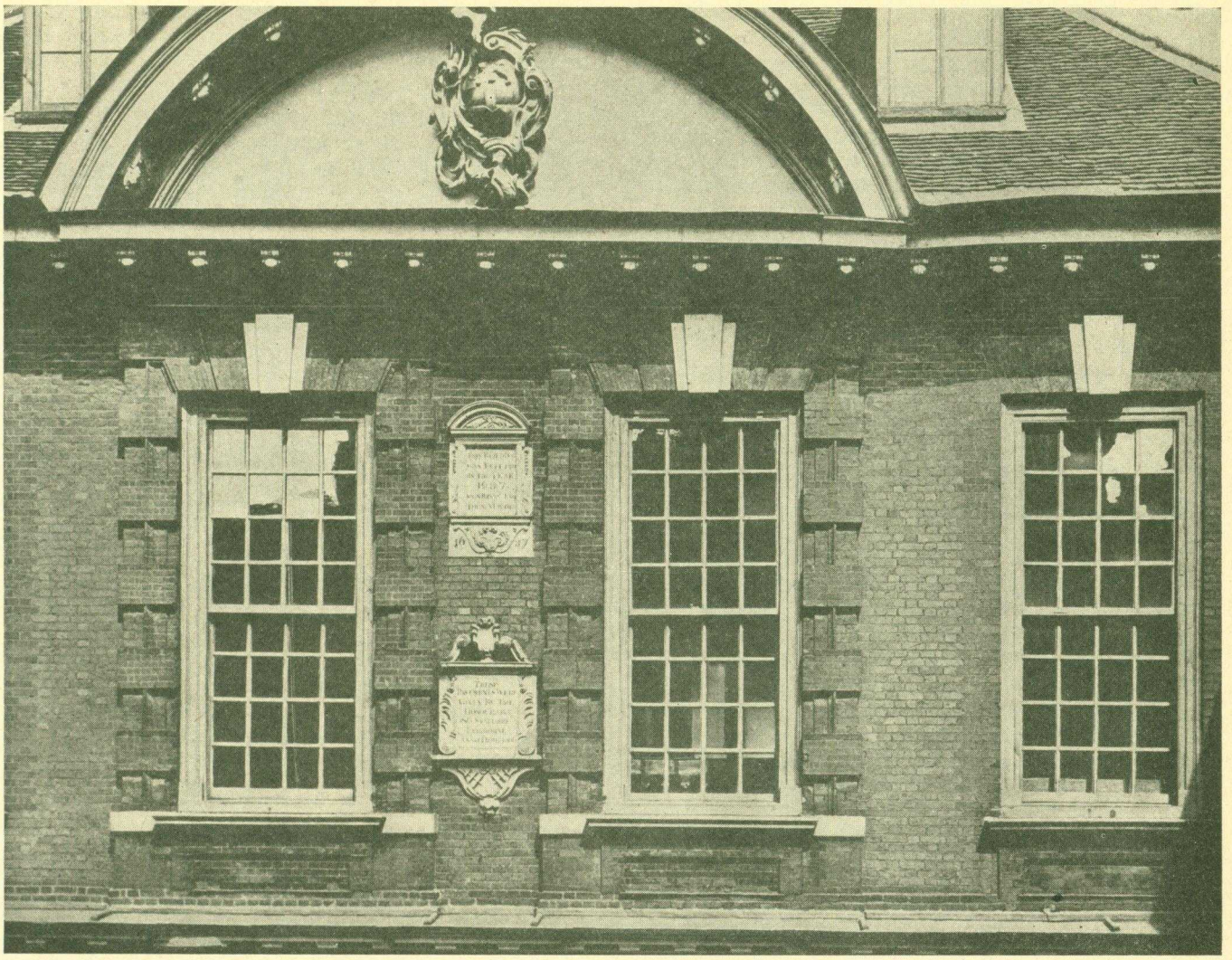


Fig. 19. Detail of the Guildhall, Rochester, England, Built 1687.

Selecting Exposed Brick:

19. To avoid misunderstanding, the grade and color effect of brick supplied for facing should preferably be determined by examples of laid work in an actual building. If this is not possible, the next best method is to select the brick from sample panels —the larger the better. It should be remembered always that even a slight change in the color, width, or cross section of the mortar joint will modify the appearance of the finished wall. It is seldom satisfactory to use a few loose brick for samples. The eye of an expert is needed to judge their exact effect when actually laid, and moreover the full beauty of brickwork is not realized when the mistake is made of selecting the brick so that they match each other exactly in shade.

Selecting Unexposed Brick:

20. Brick for unexposed work are not supplied by sample but by the name of the grade required—these names varying in different localities. The manufacturer will always gladly co-operate by supplying a suitable grade for the particular use and location in the building for which the brick is intended.

Soft or Salmon Brick Has Its Uses:

21. The attention of architects, builders and specification writers is particularly directed to the fact that it is a mistake to require that only the hardest burned brick be supplied to every job. Soft or underburned brick has enormous strength. See test results on preceding pages.

22. The outside courses of all walls exposed to the weather, foundation walls, walls and piers required to carry very heavy loads—as in many commercial and engineering structures—should always be laid in hard burned brick.

23. But for much interior work, backing up of walls faced with harder burned brick; for fire, party and division walls; and in general any location where absorption is not a factor and where great strength is not required; advantage may be taken of the lower cost and sound serviceability of soft or salmon brick.

24. Salmon brick has an unexcelled bonding surface on which to plaster direct.

Appearance of Brickwork:

25. As a result of a demand for special effects in exposed brickwork there has been developed an industry of considerable magnitude—the face brick

industry. Face brick manufacturers are able to supply a brick of any color or variety of colors desired, and by scratching or other treatment of the surface can produce any texture. In most parts of the country building material dealers can supply face brick. In other sections bricks for facing are customarily selected from the harder burned brick delivered to the job, or are marketed in special selections by the manufacturer.

26. In an ordinary residence the quantity of face brick required for the outer course is not great, and even if the best grades of face brick are selected, the additional cost will not add a great deal to the total cost of the house.

27. A well built wall of hard burned brick produced in any locality will have a most interesting and beautiful appearance if the brick are carefully laid with proper bond and due consideration given to the width, section and color of the mortar joint.

28. Many large and important structures, carefully designed as to front elevation, are built with side and rear walls fully exposed, upon which little thought has been given as to design, and little care in the laying of their common brick surfaces, on the assumption that at some future time they will be masked by other buildings.

29. In passing judgment upon the appearance of a wall built of common brick, due consideration should be given the fact that far too frequently such walls are laid carelessly, the individual bricks being capable of producing a much better effect if the same care is used in laying them that is accorded any other facing material.

30. In some localities residences are constructed with face brick on the street front only, and perhaps for two or three feet on the return. Beauty has an economic value and a far better looking group of homes would result if the same material were used all around.

Brick Harmonizes Well with Other Materials:

31. Brick harmonizes well with stone and terra cotta and beautiful designs may be worked out using these materials for quoins, belt and string courses, cornices, etc. Care should be taken that the contrast between the brick and the trim is not too great.

32. Stucco panels are sometimes used with brickwork and may be made effective. The brickwork behind the stucco should be recessed so that the face of the stucco is flush with the brick, to prevent water finding its way between brick and stucco at the top and sides of the panel.

Sorting Brick:

33. Where the face of the wall is to be laid of selected brick sorted out from the ordinary brick at the job, always locate the brick pile so that the man who is sorting can work in the shade. He will do faster and better work in the shade than in the sun.

CEMENTS AND LIMES

1. Only the widely used and most available mortar materials are here described.

Portland Cement, Strength:

2. Standard specifications of the American Society for Testing Materials require that a briquette of 1 part Portland cement to 3 parts sand by weight must have a minimum tensile strength of 200 lbs. sq. in. 7 days old, stored 1 day in moist air and 6 in water; and 300 lbs. sq. in. 28 days old, stored 1 day in moist air and 27 in water.

Portland Cement, Volume and Weight:

3. A bag contains 94 lb. net. A barrel contains 4 bags or 376 lbs. net. Packed, its weight averages 108½ lbs. per cu. ft.; loose, 92 lbs. per cu. ft.

4. Portland cement should be kept from dampness. It is well worth while to keep empty cloth bags dry. An allowance is made for bags returned in good condition.

Natural Cement, Description and Strength:

5. While natural cement is used successfully by some contractors who carefully follow manufacturers' directions, it has several objectionable qualities. It is a variable product; and it sets so rapidly that it must always be retempered before placed in the wall. Bricklayers, in fact, prefer to use it when retempered, since this increases its plasticity, but at the same time seriously reduces its strength. (Par. 23, page 39.)

6. Natural cement is not as strong as Portland cement; 1:1 natural cement mortar having about the same strength at the end of one year as 1-3 Portland cement mortar.

7. A bag contains 94 lbs. net; a barrel 282 lbs. net.

Lime, General Description:

8. Quicklime is formed by calcining limestone. It comes from the kiln in lumps and in that form is marketed under the trade name of **lump lime.** When hydrated or slaked at the plant it is called **hydrated lime.** Lime is occasionally supplied in the form of pulverized or ground quicklime.

Lump Lime, Classification:

9. There are four classes; high-calcium, calcium, magnesian, high-magnesian; the two latter also being termed "dolomitic" limes. Calcium and high calcium limes are more generally available than magnesian types. "Fat" or rich lime is more than doubled in volume when slaked. The paste is very smooth to the touch. It will carry a great deal of sand and because of its great plasticity works with great ease under the trowel, and is more economical

than lean lime. "Lean" or poor lime increases to less than twice its volume when slaked, carries less sand, and while fairly plastic is less so than fat lime.

10. Each of the four classes previously mentioned includes limes of the "fat" and "lean" varieties.

11. There is little difference in the strength of high calcium and dolomitic lime mortars. It is the custom to use the class of lime most available in the locality.

Lump Lime, Grades:

12. **Selected** is well burned, picked free from ashes, core, clinker or other foreign material. This is the better grade to order for brick mortar. **Run-of-kiln** is well-burned, without selection. Pulverized lime must pass a ¼-inch screen.

13. Do not accept lime that is old or air slaked. Fresh lime is in hard lumps with little powder. Air slaked lime is mostly powder and lumps are soft and crumbly. When water is added, lime should slake into a fine smooth paste without leaving any residue.

Lump Lime, Volume and Weight:

14. A bushel contains 75 to 85 lbs. net. A cubic foot weighs from 60 to 65 lbs. A 180-lb. barrel contains about 3 cu. ft. A 280-lb. barrel contains about 4¾ cu. ft. In this book the 180-lb. barrel is always referred to.

15. As a rough average, a 180-lb. barrel of good lime makes about 7.05 cu. ft. of putty.

Lump Lime, Storage:

16. It is advisable to slake lime as delivered and not store it. Before being slaked, it must be kept dry and prevented from absorbing moisture from the atmosphere or it may become useless. If stored, keep in a dry covered place in barrels or in an air-tight box if in bulk. The box should be fitted with a door in the lower portion for easy removal of material.

Hydrated Lime, Description:

17. Hydrated lime is a fine dry powder. It is particularly useful where space on the job is limited and there is not sufficient room to stack a supply of sanded lump lime paste; also where the time required to prepare lump lime paste is a consideration. It is of particular value where, owing to carelessness or lack of skill, lump lime might be spoiled in slaking. Hydrated lime may be more quickly and accurately proportioned than lump lime.

Hydrated Lime, Volume and Weight:

18. A cubic foot weighs 40 lbs. A paper package contains 50 lbs. net. A cloth package contains 100 lbs. net. The 50 lb. package is most generally supplied. Sold also in bulk by the 2,000-lb. ton.

19. Hydrated lime makes about 1.14 cu. ft. paste per 50-lb. bag.

Patent Brick Mortars:

20. There is a large variety of brick mortars and trademarked brick cements now on the market. Some consist of Portland cement, lime and sand mixed dry and sold in bags. Others consist of natural cement mixed with hydrated lime or Portland cement. One brand of brick cement used widely in the Middle West is a natural but non-hydraulic cement, slow-setting (can be retempered the next day), swells about half in volume soaked in water, and tests show it very strong when fully set.

21. The previous performance and actual properties of any patent brick mortar should be carefully investigated and it should be used according to manufacturer's directions.

SAND AND MORTAR COLORS

Sand, Description:

1. Sand should be clean, with sharp angular particles free from vegetable matter, loam, large stones and dust. Pit sand makes the best mortar. If it cannot be obtained, good sharp sand can be often found in river beds. Sand with rounded particles makes weaker mortar than sharp sand.

2. A simple test for cleanliness is to squeeze some wet sand in the hand. If loam is present the sand will retain its shape. If not it will have a gritty sound and rubbed on the palm will not leave a slimy deposit. Another test is to place some of the sand in a glass bottle with water, the level of the water being an inch or two above the top of the sand. After settling, most of the loam will be at the top of the sand.

3. A small amount of organic impurities will decrease the strength of the mortar and if sand contains over 5 per cent. of loam the strength of the mortar will be very seriously reduced and such sand should not be use unless first washed.

Coarse Sand Makes Densest and Strongest Mortar:

4. Recent tests by A. N. Talbot at the University of Illinois on mortar made with coarse, medium, fine, and very fine sand show that with very coarse sand the mortar has the least percentage of voids, and with very fine sand the highest percentage; the medium also has a lower percentage than the fine; the amount of water being equal in each case. Mortar containing fewest voids is strongest, and is best obtained by using a well graded sand.

Sand, Screening:

5. Sand should always be screened or much time will be lost by the bricklayers having to dig out larger stones while spreading mortar. Use a screen with a long vertical spacing and narrow horizontal spacing. It will screen the sand faster than a screen with square openings. A No. 4 screen, with four meshes to the inch, is most commonly used.

Sand, Volume and Weight:

6. Sand is sold in some localities by the cubic yard (27 cu. ft.). In other sections it is sold by the 2,000-lb. ton; approximately 20 cu. ft.

7. A cu. ft. weighs approximately 100 lbs. A one-horse load is about one yard or 27 cu. ft. A two-horse load varies from 2 yards to 2½ yards; the former being a fair, the latter a large load.

Natural Mortar Colors:

8. Mortar may be colored by using colored sand, ground granite or other stone and where the desired shade can be thus obtained these are preferable to artificial colors, because natural sands and stones have an unquestionably permanent color and do not weaken mortar. The color of the sand in the finished joints will be modified, however, by the uncolored cementing material which appears between and covers some of the sand particles.

9. Pure white joints may be obtained with white sand, ground limestone or marble.

Artificial Mortar Colors, Description:

10. Special care should be taken to select good artificial mortar color. In some districts contractors have a habit of ordering from hardware stores indefinite products such as venetian red, yellow ochre and lamp black for use in mortar. These colors may or may not be good; many expensive pigments being unsuited for such use. Mortar has a strong alkaline action and coloring materials should be chemically inert or the color may fade or run when in the wall. Mineral colors are preferable. Mortar color should be obtained from a reliable building material dealer and a brand selected that has actually stood the test of time, manufactured by a thoroughly responsible concern. Any artificial mortar color will fade somewhat in the sun, however. (See also pars. 17-18, page 46.)

Artificial Mortar Colors; How Supplied:

11. Artificial mortar colors are in two forms, pulp or paste, and dry powder. Pulp colors are more expensive than dry powder and have not as much coloring power per unit of weight. They are easier to use because less labor is required to thoroughly incorporate them with the mortar.

Artificial Mortar Colors; Quantity Required:

12. Manufacturers' or dealers' directions should be followed as to quantity. The more thoroughly color is mixed less is required to produce a given shade. The amount required depends also on the color used. As a fair average, it takes upwards of 100 lbs. dry powder per thousand brick in a solid wall with ½-inch joints. For pulp color add 20%. For Ideal all-rolok walls 50% of the amount needed for a solid or Ideal rolok-bak wall is ample.

13. Some dealers, to emphasize the efficiency of the particular brand of color they deal in, recommend the use of comparatively small quantities. If colors are very thoroughly mixed, smaller quantities may accomplish the purpose, but to avoid disappointment it is better to order an ample quantity, especially as the difference in cost is slight.

14. Figure an amount necessary to lay the outer course and a little over. If the bricklayer runs out of uncolored mortar, it is cheaper to have him continue work and lay the back of the wall with colored mortar, than to stand and wait for uncolored mortar.

Mixing Colored Mortar:

15. Mix the mortar to a stiff consistency when using artificial colors. If color is added after the mortar is made, much more labor is necessary. Never mix mortar colors with hot lime, for hot lime will bleach out the color.

16. Dry colors, when soaked a few days, will mix more easily with the mortar and go further than when mixed dry; in fact, it is advisable to have a barrel in which to keep a supply of dry color mixed with water. When required, stir with a stick and bail out the quantity required.

Colored Mortar, Strength:

17. Although artificial colors may reduce the strength of mortar by adding to the fine matter in its composition; brickwork has such a high factor of safety that for ordinary purposes this slight reduction in strength need not even be considered when good colors are used.

Selection of Colors:

18. The same procedure for selecting colors should be followed as for selecting brick (Page 34, par. 19).

SELECTION AND PREPARATION OF MORTAR

Function of Mortar:

1. A brick wall is bound together in two ways; first by the mechanical bonding or overlapping of the brick, and secondly by the properties of the mortar. The strength of brickwork is thus doubly safeguarded. Brick itself has an enormous factor of safety, and any well bonded wall will safely bear considerable loads. Good mortar is essential to good brickwork and a wall with poor mortar will not carry the loads that are possible when the mortar is up to standard, or be as satisfactory; but with brickwork a poor batch of mortar does not ordinarily involve the risk of failure. Pars. 36 and 43, page 31.

2. Mortar in horizontal joints provides an even bed for supporting the courses above, and in all joints serves to unite the brickwork into one mass by its adhesive properties and prevents the penetration of wind and weather between the brick units.

Selecting Mortar:

3. Three factors should be considered (**a**) the required strength and exposure of the brickwork, (**b**) the cost of the mortar itself, (**c**) the degree of its plasticity. With a smooth easy working mortar more brick can be laid in a day by each bricklayer. This smoothness generally depends upon the amount of lime which it contains. For strength of mortars see pars. 28-31, page 30.

Mortar for Wide Exposed Joints:

4. It is difficult to lay brick on a bed of soft mortar ¾" thick and over; and to stiffen the mortar as well as to form a rough granulated texture, very coarse sand or even fine gravel should be mixed with the sand, the size of the particles increasing with the thickness of the joint.

Portland Cement Mortar, Where Used:

5. Is recommended for piers or walls which carry heavy loads, for wet or very exposed situations, fire

and party walls, work under water, brick footings, sills, chimney and parapet caps, free standing chimneys above roofs, brick steps, cheek walls to steps, brick porch and terrace floors and similar exposed locations and for use in freezing weather.

6. It is sometimes used throughout a building. It is the highest in cost of all the mortars.

Portland Cement Mortar, Composition:

7. Mortar composed of Portland cement and sand is not plastic. It works "short" and some is wasted because much of it near the edge of the bed rolls off. Laying brick with pure Portland cement mortar is slow and difficult and the bed joints are not so thoroughly filled as with a more plastic mortar. Thus, although pure Portland cement mortar is the strongest, the actual brickwork may not be as strong as when part of the cement is replaced with lime. (Pars. 28-30, page 30.)

8. About 10% by weight of the cement is generally replaced by dry hydrated lime or its equivalent in lime paste. When so proportioned it is generally called "Portland cement mortar" in distinction to "Pure Portland cement mortar." This proportion is figured in the tables at the end of the book.

9. A good proportion for first class mortar is I part Portland cement (of which part is replaced with lime as above) to three parts sand, by volume.

Cement-Lime Mortar, Where Used:

10. Cement-lime mortar will set in damp places but is not as weather resistive as Portland cement mortar. Consequently, for wet places and very exposed situations, such as freestanding chimneys above roofs, the latter is preferable.

11. We especially recommend cement-lime mortar made with Portland cement for use in constructing Ideal walls above and below ground.

12. It is also generally recommended for masonry carrying heavy loads, for all solid residence walls above footings, for fireplaces and flues, (par. 28, page 61) and for locations where the work is partially protected, such as veranda posts and piers.

13. Cement-lime mortar costs less than cement mortar but more than lime mortar.

Cement-Lime Mortar, Composition:

14. Cement-lime mortar is plastic and works smoothly and easily under the trowel. and produces brickwork of high strength. (Pars. 28-30, page 30.) As many brick can be laid per day with this mortar as with lime mortar. It is similar to Portland cement mortar above described, except the proportion of lime is greater. A mix that proves very strong and economical is a 1:1:6 proportion. (See tables at end of book.)

15. Natural cement can be used instead of Portland cement but makes a weaker mortar, although possessing ample strength for ordinary structures. The lime delays its naturally quick initial set and makes it a more usable material for brick mortar. Manufacturer's directions should be followed for exact proportioning.

Cement Mortars, Preparation:

16. In mixing cement or cement-lime mortar the cement and sand should first be mixed thoroughly while dry. Hydrated lime, if added dry, should also be mixed with the dry cement and sand. This is best accomplished by spreading the material in thin layers one over the other in one end of the previously cleaned box, and turning the mixture over three or four times with shovels or hoes.

17. If lump lime paste is added, it should be slaked and aged several days before it is mixed with the cement. Never mix hot lime with cement, for hot lime weakens it. (See par. 40, page 40.)

18. The mixture should be hoed from end to end of the box until thoroughly incorporated. The consistency should be such that the hoe is clean when withdrawn from the mortar.

19. There is danger in using too much or too little water. An excess "drowns" the cement, retards setting and weakens the mortar. Too little water will weaken or even spoil the mortar.

20. Cement or cement-lime mortar should be used without much delay and made in small batches as required. (See also pars. 22-26.) There should be no mortar left overnight. It will be useless the next day.

Natural Cement Mortar:

21. Natural cement mortar may be used in walls or piers carrying heavy loads which will not be exposed to dampness for one month after being laid. It should not be used in very exposed situations.

Retempering Cement Mortar:

22. Specifications usually read that cement mortar shall not be retempered after taking its initial set. When larger quantities of mortar are mixed than are required immediately, however, the usual custom is to re-temper it, adding water that may have disappeared by evaporation.

23. Retempering makes cement mortar more plastic and delays the final set. It seriously decreases the strength of quick setting cements, such as natural cement. Prof. Ira O. Baker* states that natural cement may lose 30 to 40% strength by retempering after standing 20 minutes and 70 to 80% after standing 1 hour.

24. With a slower setting Portland cement, the loss of strength is probably not serious if the mortar is retempered immediately after the initial set. Tests mentioned by L. C. Sabin† show that retempering is not deleterious to the tensile strength of Portland cement mortar if it is retempered several times during the period in which it is standing. It should not be allowed to stand undisturbed for any length of time. The loss of strength is greater with fine sand than with coarse.

25. Retempered mortar shrinks more than ordinary mortar in setting and may cause small cracks to appear on the surface of the joints. Mortar insufficiently mixed may have its strength increased by retempering.

26. The safest procedure is not to use mortar which has taken initial set, especially natural cements and quick setting varieties of Portland cement.

Lime Mortar, Where Used:

27. Lime mortar is recommended for house construction above ground, except where very heavy

* "Treatise on Masonry Construction" page 100.

† "Cement and Concrete" page 252.

loads have to be carried on brick piers, or where walls are much cut up by window or door openings, or in very exposed situations. It is the lowest in cost of all the mortars.

28. It should not be used for exterior basement walls subject to a great deal of dampness, unless the wall is thoroughly water-proofed outside, because excessive dampness, if long continued, makes it lose its binding properties.

29. Straight lime mortar should never be used for fireplaces and flues.

30. Lime mortar hardens slowly and gets stronger with age.

Lump Lime, Preparation:

31. It is slaked by being placed in the mortar box and adding water. It becomes very hot, giving off vapor and bursting into powder which reduces to a paste called lime putty.

32. Every lime requires slightly different manipulation and the best results can be obtained by following manufacturer's or dealer's directions, in the absence of which these suggestions are made. Experience is the best teacher and experienced labor should be used for this purpose.

33. The higher the percentage of calcium the more quickly the lime slakes and the more heat is generated. Calcium limes are known as quick slaking limes. A magnesian or high magnesian lime will slake more slowly, combine with less water, generate less heat, undergo less increase in volume, set more slowly, and shrink less than a high calcium lime. Magnesian limes are known as slow slaking limes. High calcium limes may slake in a few minutes; high magnesian limes may take half an hour.

34. With quick slaking lime always add lime to the water, with medium limes add water to the lime. Care must be taken with quick slaking lime to have sufficient water in the box before the lime is shovelled in to prevent "burning" or overheating. Hoe thoroughly and quickly and add more water at the slightest appearance of escaping steam.

35. With slow slaking limes the danger lies in putting on too much water. Just moisten a slow lime at first, cautiously adding more water as slaking proceeds. Do not hoe until slaking is practically complete. Use hot water in cold weather, or if this is not practicable keep the mortar box covered.

36. "Burned" lime is granular, non-plastic and will not bind the sand together; "drowned" lime is lumpy and watery. Both are practically useless for making mortar.

37. The laborer should have a good supply of water. A barrel of water and a pail should be handy for quick action if the lime starts to burn.

38. As soon as the slaking process is complete, mix the sand with the paste and shovel it out on the wood platform, to remain until it is tempered for use.

39. Sometimes where a poorer grade of lime is used, there is a residue of impurities after the lime is slaked. In such cases slake the lime in a separate box, afterwards screening it into the mortar box and mixing it with the sand. Such lime does not generally make so strong a mortar as that which leaves no residue. It is a cheaper grade and for that reason is used for much ordinary low cost work.

Seasoning Lime Putty:

40. Lump lime should generally be slaked at least one week before being used. This is a safe rule to follow, although some limes can safely be used two or three days after slaking. At the time of slaking, some of the lime particles may escape the slaking process. If the mortar is mixed and used too soon these particles of free lime will afterwards take up water, causing the mortar to be crumbly and to "pop". Ageing lime paste enables it to carry more sand.

Hydrated Lime; Preparation:

41. Most frequently hydrated lime is mixed directly with the sand. When so mixed it does not trowel so easily as mortar made from lime putty. The working qualities of the hydrate can be improved by allowing the mortar or paste to soak over night. Hydrated lime does not require slaking.

Proportioning the Sand:

42. There is no set rule regarding the proper proportion of sand to lime. If there is too much lime in the mortar, it sticks to the trowel. If there is too much sand, it is stiff and difficult to work. If the sand particles are very fine, more lime will be required. Experience is the best guide to the proper proportioning. The sand quantities in the tables must be regarded as approximate only.

Tempering Lime Mortar:

43. When the sanded and stacked lump lime paste is required for mortar, it is shovelled back into the mortar box and "tempered" for use. This is done by adding water and working it to proper consistency, a condition reached when the mortar slides easily off the trowel. It should be hoed from end to end of the box until the lime is thoroughly distributed throughout the mass. If lime is left in spots or small masses, the mortar will not be as strong or as efficient.

LABOR MAKING MORTAR

1. All labor required to slake lime and mix mortar is included in the item "laborer's time" in the tables at the end of this book. The following information may, however, be found useful.

Labor Slaking Lime:

2. A laborer with some experience in making mortar should be able to slake, sand and stack about 1⅜ barrels of lime per hour or 11 barrels per 8 hour day.

Labor Mixing Mortar:

3. The time required for mixing and tempering mortar per 1000 bricks varies from 1 to 1½ hours, depending on the thickness of the mortar joints. These figures apply both for lime and cement mortar. For lime mortar it also includes the time required to slake the lime. One mortar maker should supply 8 bricklayers. With a power driven mortar machine one man can supply from thirty to fifty bricklayers, but of course will require some assistance in having sand, etc., wheeled to the machine. It is long run economy to have expert mortar mixers and to keep the bricklayers amply and carefully supplied with mortar as well as bricks.

EQUIPMENT FOR MORTAR MAKING

(See also equipment for brick construction, pages 61 and 62.)

Mortar Bed:

1. For mixing mortar, there should be provided a watertight mortar bed or box. This is sometimes built according to Fig. 20. With this type of box the bed is made by spreading a three or four inch layer of sand on the ground. On this lay three 2″ x 10″ planks the width of the box. On these planks lay at right angles the 2″ x 10″ planks forming the floor. The sides and ends of the box (which are permanently nailed together) should then be placed on the bottom and the corners and any holes in the bottom plastered with mortar to prevent the escape of cement or lime putty. A box of this kind being made of several pieces is easily taken from one job to another.

2. Other contractors prefer to build a box of thinner and lighter material permanently nailed together —some using 1″ boards. The bottom is then supported on three or four pieces of flat 2 x 4 placed crosswise of the box and nailed on permanently.

Colored Mortar Box:

3. Where only a small amount of colored mortar is to be used it is sometimes mixed at one end of the large mortar box. In some cases a board is used to partition it off for this purpose. Where a larger quantity is required a separate colored mortar box should be used, the regular size being about three feet by six feet; constructed of light material so it can be moved from one job to another.

Platform:

4. Where lump lime is used a platform for stacking mortar is provided, for lump lime should be slaked when it comes on the job and in any case a week's supply must be kept on hand.

5. This platform may be constructed of loose plank as described for the first type of mortar box, the planks resting upon one or two other plank laid at right angles, supported on sand.

Lime Bed:

6. To age a large quantity of lime paste some contractors simply spread a thickness of sand on the ground with a depression in the middle, in which the slaked lime is stored.

Barrels and Tools:

7. A hose connected with the water supply, a mortar hoe, and a shovel are necessary. Where lump lime is to be slaked, even if there is a hose which will throw a good stream, it is well to have a barrel of water and a pail in case the lime begins to burn while slaking. Where there is no city water supply two or three barrels should be provided. If dry mortar colors are used, in another barrel may be kept a supply soaked in water.

8. The cost of mixing mortar can frequently be reduced and a more uniform mixture obtained by the use of a small power driven mortar mixing machine.

Locating Mortar Bed:

9. The box and platform should be several feet from the building to avoid splashing the wall. They should not be located at such a distance that the mortar will have to be carried very far. Where an inclined way is used to wheel or carry materials to any story the box should be somewhere near the bottom of the incline, or near the hoist if this is used. The sandpile is placed near the box and so located that a team can drive up and deposit sand.

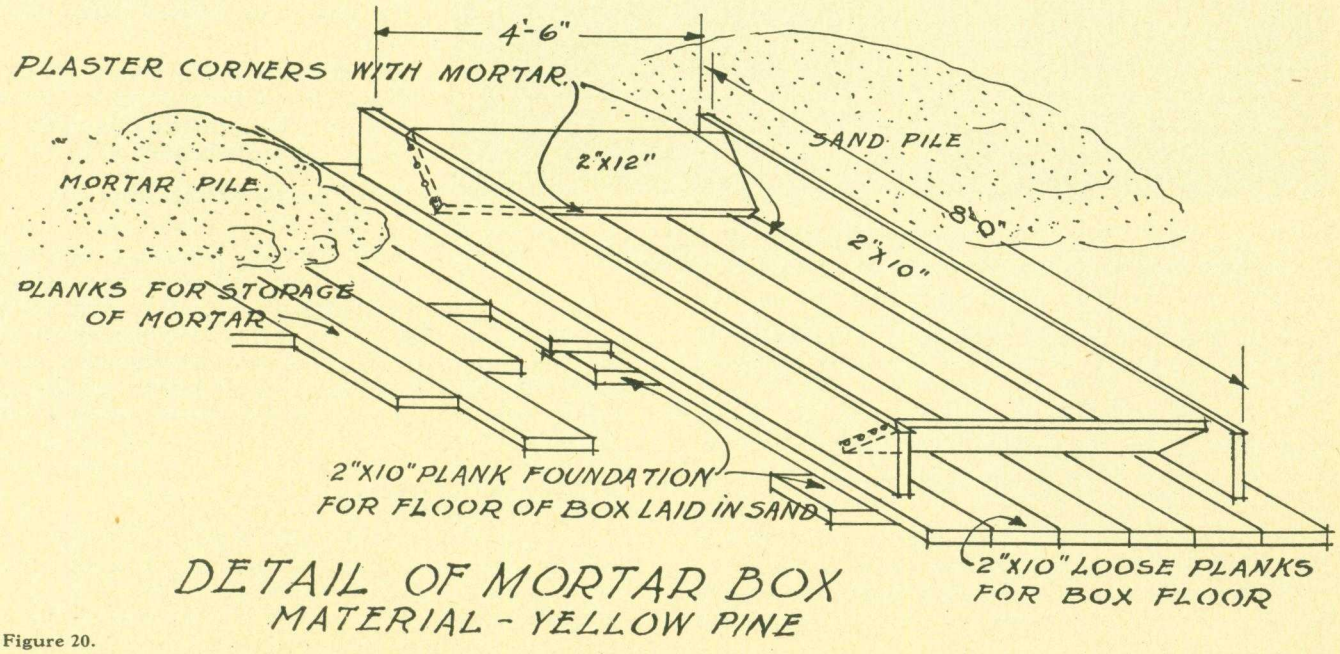


Figure 20.

BONDS AND JOINTS

BONDS

Bond; Definition:

1. The full strength of brickwork cannot be attained without good bond. The word bond means "to bind." Bond is the method of arranging the brick units so that by their overlapping the entire wall is thoroughly tied together throughout its length and breadth and will act as a unit in resisting stresses.

2. "Stretchers" or brick laid lengthwise of the wall, develop its longitudinal strength.

3. "Headers" or brick laid across the wall, develop its transverse strength.

4. Every type of brick wall is enormously strong and will carry great loads when properly built; so that for structures not carrying heavy loads, the relative strength of the various types of bond need not be considered.

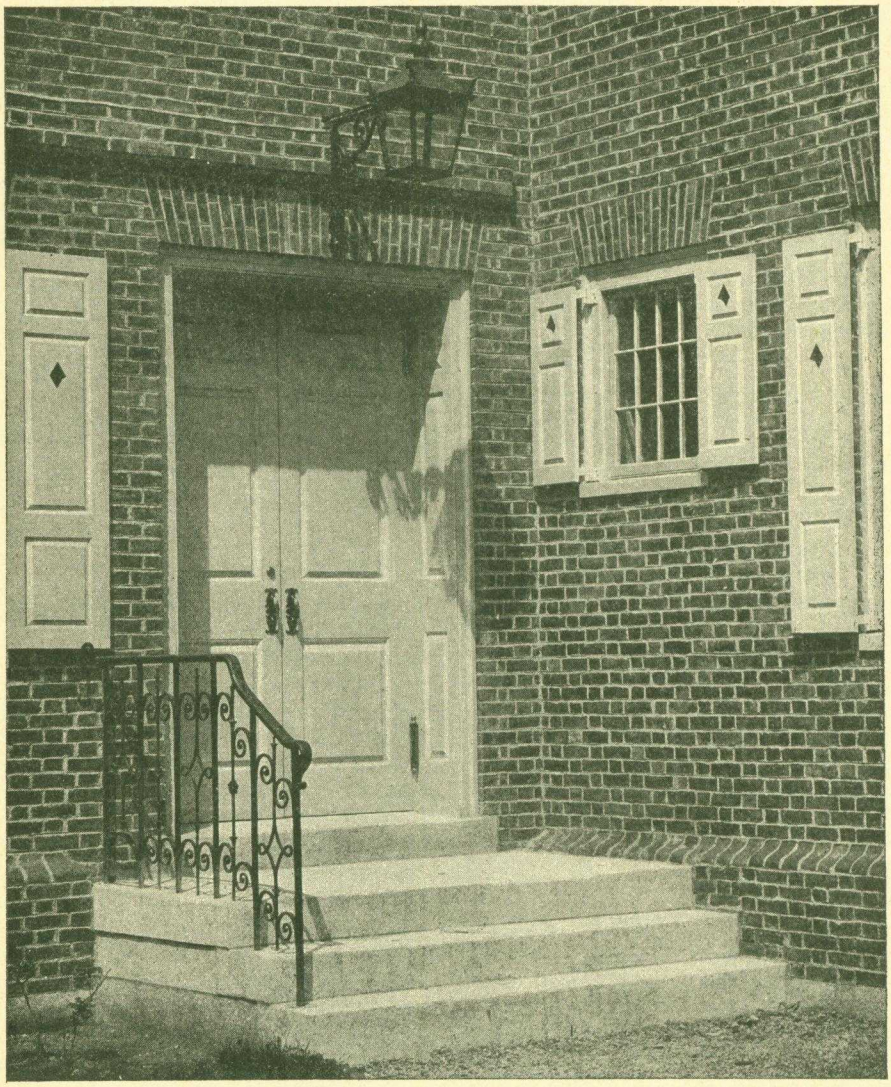


Figure 21. Detail of Harvard Freshman Dormitories, Cambridge, Mass. Flemish bond with concave joints (Diagram G page 47). Note the charming effect of the contrast between the light mortar and darker brick. Note also special plinth bricks. "Jack" arches formed as described in pars. 76-77, page 57.

Headers in Solid Walls:

5. The brick walls in an ordinary building are never called upon to support more than a small part of the load they will safely bear. If the foundation settles unevenly, however, some stress may be caused in the direction of the length of the wall; although the brick wall is adapted to adjust itself to slight movements such as this without cracking or other damage, by reason of its small units and numerous joints.

6. It would appear logical, therefore, to build a solid wall mostly of stretchers, with just enough headers to tie it together. (See also strength of bond in piers, pars. 20-27, and Tables 7 and 8, pages 29-30.)

7. In a solid wall built entirely of common brick, all the headers which appear on the face of the wall are real or "through" headers. Where face brick are used, it is most economical to make all headers not required for ties, bat headers, so that the face brick will go further. Face brick should be cut at the middle so that each half of the brick can be used for this purpose and waste avoided.

8. The number of through header courses is generally defined by building ordinances. Placing a header course at every sixth course (five non-header courses between) is a safe rule, however, except where the backing brick is laid on a full bed of mortar but with dry vertical joints, in which case through headers should be placed every fifth course.

9. Header courses may consist of a full course of headers, or of headers and stretchers placed alternately (Flemish header course.)

Small Units Make Stronger Wall:

10. Because of its numerous units, brick masonry possesses a considerable degree of elasticity, enabling it to adapt itself, with least possibility of cracking or damage, to slight, irregular movements in the bearing soil which may be expected to occur even in the first few years of the centuries a brick structure lasts.

Appearance of Bonds:

11. In exposed work, the bond fulfills another purpose, the mortar joints forming attractive geometrical patterns on the surface of the wall, this being an important factor in the beauty of brickwork. Brick units laid flat or on edge have the proper

relation of height to length, which gives an appearance of stability and harmonious proportion, and the units are of such size that any architectural composition may be designed in scale of these units or patterns to suit. The jointing should be such that the brick units can be clearly seen, even at a distance. This is of great importance in producing successful brickwork (par. 17, page 46).

Selection of Bond:

12. Cost and appearance should be chiefly considered except for extremely heavy loads. For exposed work the best bond will be determined by the architectural design. For unexposed work and exposed low cost work, common bond is generally employed, costing least because easily and quickly laid and in practice being probably the strongest of the bonds. Many charming buildings are, however, faced with brick in common bond. For piers or walls carrying heavy loads lay the bricks on edge. (Pars. 20-27, and Tables 7 and 8, pages 29 to 30.)

13. Flemish bond is most practical for facing Ideal all-rolok walls. Any bond may be employed for facing Ideal rolok-bak walls.

14. The same procedure should be followed for selecting bond as for selecting exposed brick. (Par. 19, page 34.)

Types of Bond:

15. There are three basic types of bond and a multitude of variations of each: Running Bond, Flemish Bond and English Bond.

Running or Stretcher Bond:

16. The surface of the wall is made up of stretchers which break joint at the centre. (Fig. 23; see also Fig. 38, page 47.) At the corner a header appears at each alternate course. Because of lack of headers the bond is weak transversely. Only full headers have sufficient rigidity and bonding area to distribute the load so that the outer course carries its normal proportion. In a solid wall twelve or more inches thick, sometimes the brick in the centre is laid diagonally every few courses, the triangular portion of the brick projecting beyond the backing, forming a tie sufficient only to attach the face brick to the backing (clipped bond, Fig. 22.) Metal ties are sometimes used, (Fig. 23) but with each of these methods only the backing can be calculated to support the load. Metal ties are unsatisfactory also because they are liable to rust and their use is not recommended.

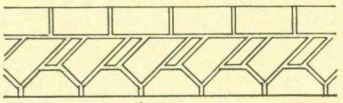


Figure 22.

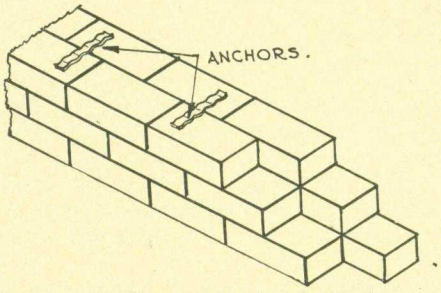


Figure 23. Running bond with metal ties.

17. Double headers are sometimes used with a buttered joint between at every sixth or seventh course, the pair of headers appearing as a stretcher. This forms a thoroughly good bond, in reality a form of common bond.

Common Bond:

18. A variety of running bond but with every fifth, sixth or seventh course a header course, either "full" or "Flemish," the former being all headers, the latter with headers and stretchers alternately. More bricks are laid in this bond than several times all the other bonds combined. It is used for exposed and unexposed work and is the lowest in cost for solid walls or for facing Ideal rolok-bak walls. This bond is shown on plates 6 and 7.

19. A "three quarter" brick is laid at the corner of each header course; brick in other courses not requiring to be cut at the corners to make them break joint. In a twelve inch wall two header courses are used, one on each side of the wall in adjoining courses, overlapping in the centre of the wall. (Fig. 24.)

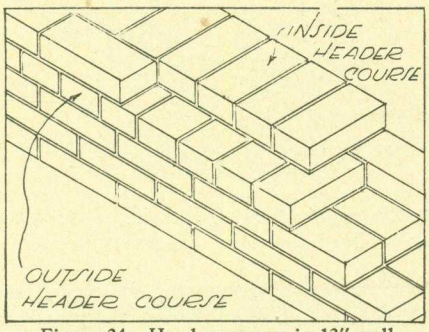


Figure 24. Header courses in 12" wall, common bond.

20. For exposed work the joints are kept perpendicular, but for unexposed work the brick does not require such careful placing. The end of a stretcher can be placed anywhere within the centre 4" of the stretcher below and still produce a good bond. (Fig. 25.) This flexibility makes for rapid work.

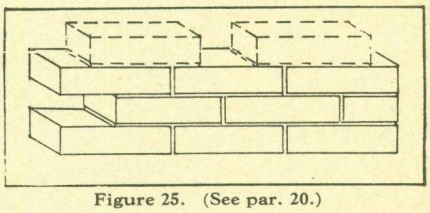


Figure 25. (See par. 20.)

Corners in Flemish and English Bond:

21 Before describing the above bonds, attention is called to two distinct methods of starting corners with each of the above types of bond. To correctly locate the vertical joints it is necessary to introduce at the corner a unit half a header in width. In English brickwork a header split in half or "closer" is used, (lower illustration, Fig. 26, also Fig. 37, page 47), but in Dutch brickwork the closer is eliminated and the same effect obtained by using a three quarter brick in the stretcher courses. (Upper illustration, Fig. 26.)

22. If a "closer" is used, never place it directly at the corner. Start with a full header, followed by the closer.

Flemish Bond:

23. This bond is a great favorite among builders, being easy to lay and producing a very artistic and pleasing wall surface. It costs more to lay than common bond, as shown in the tables, but is more attractive in appearance. (Fig. 26, also Fig. 21, page 42, and Figs. 34, 35, and 37, pages 46-47.)

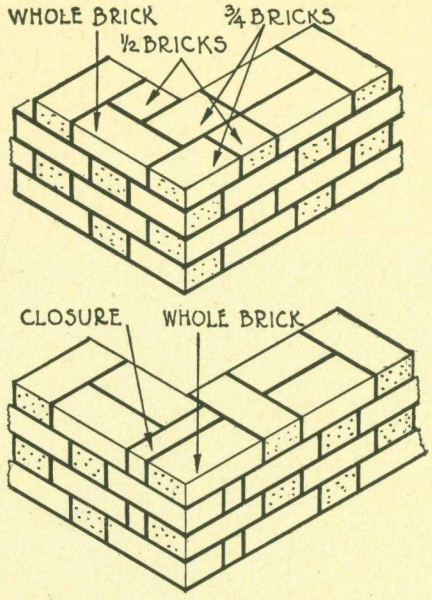


Figure 26. Corners formed with and without closers (Par. 21.)

Double Flemish Bond—Garden Wall Bond:

24. A variety of Flemish, with two stretchers followed by a header in each course, the header centered on the pair of stretchers. (Fig. 27.) In double Flemish bond the joint between the pair of headers is a blind or invisible joint, this constituting the sole difference between double Flemish and garden wall bond; in which latter the joint has the usual appearance. It may also have from two to four stretchers between headers.

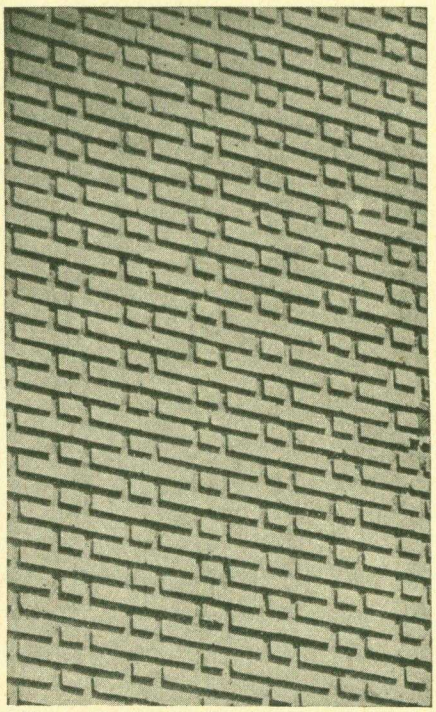


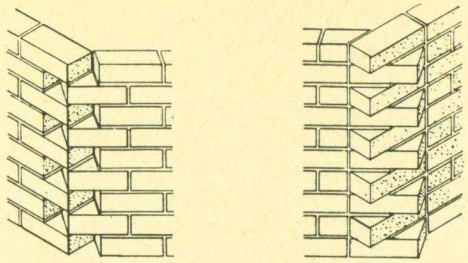
Figure 27. Double Flemish bond, stripped joints. (See also Fig. 38, page 48.)

English Bond:

25. Composed of alternate courses of headers and stretchers, headers centering on stretchers or joints between them. Joints between stretchers are vertically over each other in all stretcher courses. Note alternate methods of forming corners. At the right of the external corner closers are used, on the left three-quarter brick avoiding closers. (Fig. 29.)

English Cross or Dutch Bond:

26. Similar to English bond, but an interlacing pattern of Greek crosses is produced by breaking



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TYPE OF OBTUSE ANGLE CORNER NOT RECOMMENDED. THIS DETAIL LEAVES "PIGEON HOLES" IN WHICH DIRT CAN ACCUMULATE, TO BE WASHED DOWN THE FACE OF WALL AFTERWARDS.

RECOMMENDED OBTUSE ANGLED CORNER. MAY BE MADE AN EFFECTIVE FEATURE OF THE DESIGN.

Figure 28.

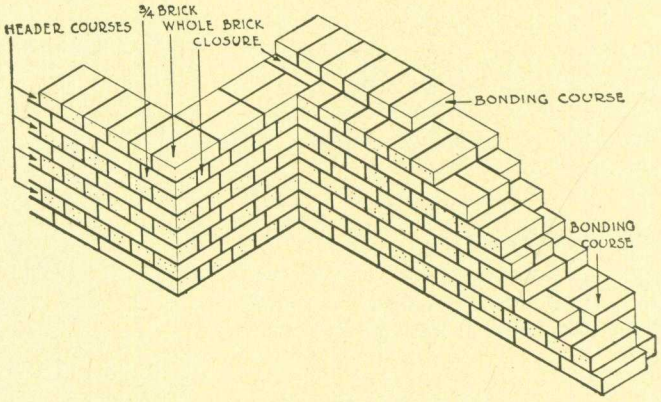


Figure 29. English bond.

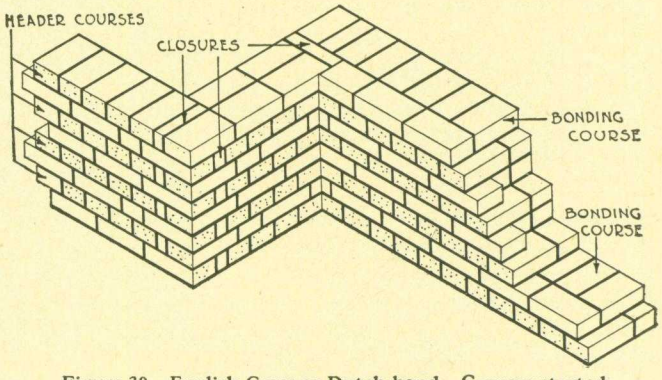
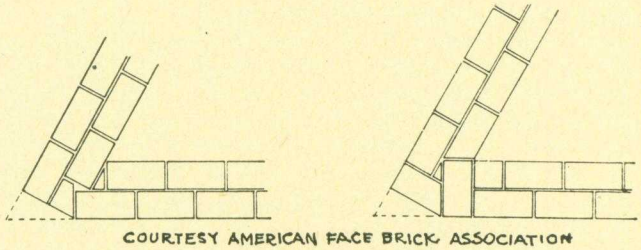


Figure 30. English Cross or Dutch bond. Corners started with closers.



COURTESY AMERICAN FACE BRICK ASSOCIATION

ACUTE ANGLE CORNER SHOWING ALTERNATE COURSES

Figure 31.

joints in the stretcher courses; ends of stretchers in each stretcher course centering on stretchers in courses above and below. (Fig. 30.)

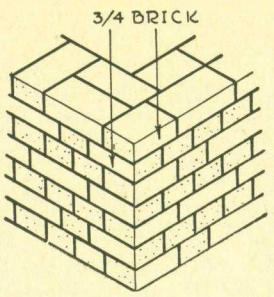


Figure 32. English cross or Dutch bond, corner started without closers.

Bond in Backing:

27. Whatever bond is used on the face, unexposed backing is always laid in common bond.

Brick Patterns:

28. Large scale patterns formed by the geometrical arrangement of various colored bricks and joints are very effective if the designs are appropriate and scale with the elevation. For large wall surfaces such patterns may be used to splendid advantage but for the ordinary residence or small building they should be employed with caution to scale with the building. More bricklayers' time is required to form patterns than to lay the ordinary bonds.

JOINTS

Shoved Joints:

1. On a bed of mortar a little thicker than the finished joint will be, the brick is pressed downwards and sideways, the soft mortar rising between and filling the vertical joints. Used for solid walls and piers and the outside 4″ thickness of Ideal rolok-bak walls.

Grouted Joints:

2. The brick are bedded on a full bed of mortar, vertical joints being filled with grout composed of similar materials with more water added.

3. To grout a wall quickly and conveniently, provide each bricklayer with a bucket of water and a long handled dipper. After placing a course of brick (laid the thickness of a joint apart) and taking the dipper with his left hand, trowel with his right, he picks up a trowel of mortar and a dipper of water with one motion. Spreading the mortar with one hand, he adds water from the dipper with the other, meanwhile working the mixture between the joints with his trowel until they are completely filled.

4. Grout is used in solid walls 12″ or more thick, the outer and inner courses being "shoved" with mortar of ordinary stiffness to retain the grout. Grouted brickwork is less expensive than shoved brick work and accomplishes the same purpose; but should not be employed where the face is to be left exposed on account of occasional trickling.

Filled Joints; Where Required:

5. The strongest and most fire-resistive brickwork is laid solid with all joints full of mortar and for fire, party and division walls, and for construction in which piers or walls carry heavy loads and resist considerable stresses, all joints should be filled. Chimneys should have all joints especially well filled, including against the flue linings to insure a good draft.

6. Basement walls required to resist considerable dampness should have all joints filled.

7. In all walls exposed to the weather, the outside 4″ course should be "shoved".

Specifications Should Not Always Require "All Joints Filled":

8. It is a mistake to specify "all joints filled with mortar" for all work. It is a difficult matter to get a mason to shove all the brick he lays, for a man's hand will be raw and tender after shoving brick all day. Theodore F. Laist, Senior Architect of the Division of Valuation, Interstate Commerce Commission, states that requiring all brick to be shoved "generally adds unnecessarily to the expense. . . . . In some respects not filling the joints is an advantage since it creates an air space in the walls."*

Open Joints, Where Allowed:

9. For solid construction above grade in common bond in a residence, a wall can be constructed by laying all the brick on a full bed of mortar, with joints in the outside course exposed to the weather shoved full, the brick in the backing (or in the full thickness of an interior partition) touching end to end and the vertical space between each 4″ thickness left open. Every fifth course should be a header course with full joints and the mortar mixed softer than usual.

10. For walls built this way with other bonds, the exterior eight inch thickness should have as many of the vertical joints running parallel with the length of the wall left open as is practicable. If thicker than 8″, lay the remaining thickness as described above for exterior walls above grade.

11. In the walls described, the partial interruption in the contact of material through the wall is considered to make the latter more weather resistive. Such a wall is also cheaper to lay, appears to dry out more quickly and is amply strong for ordinary loads.

12. Basement walls in fairly dry soils may be laid with the outer joints shoved full, the brick in the remaining thickness laid on a full course with brick touching end to end and the vertical space between each 4″ course filled with mortar.

Dry Joints:

13. Sometimes in low cost work every sixth course on the interior face of a wall is laid directly on the brick below, omitting the bed of mortar. "Dry" horizontal joints provide secure nailing for grounds, frames, etc., but weaken the wall and are not recommended.

*American Contractor for Dec. 4, 1920.

Joints in Ideal Walls:

14. The facing and backing in all Ideal walls should have full joints. The end joints of brick on edge are filled by "buttering" the bricks before they are placed.

Exposed Joints:

15. The mortar joint constitutes a considerable proportion of the area of the finished wall and hence should be considered as to (a) width, (b) color, (c) section, (d) texture.

16. With a standard brick two headers require a ½" joint to coincide with the length of a stretcher. In forming bonds and patterns the ½" joint is thus most practical. Joints ⅝" and ¾" wide are used extensively and are very effective, the difference between the unit length of a stretcher and two headers plus a joint being taken up by slightly varying the width of the vertical joints. Joints 1" and even wider have been used. A joint of ¾" and over slows down the work, a thick bed of soft mortar under each brick being more difficult to manipulate. Special mortar should be used for wide joints. (Par. 4, page 38.)

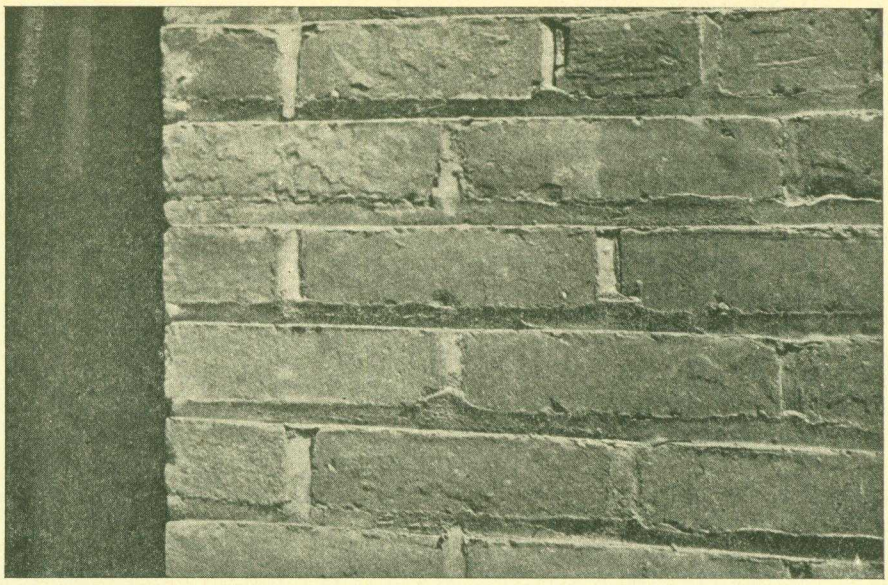


Figure 33. Struck joint, diagram A, common bond.

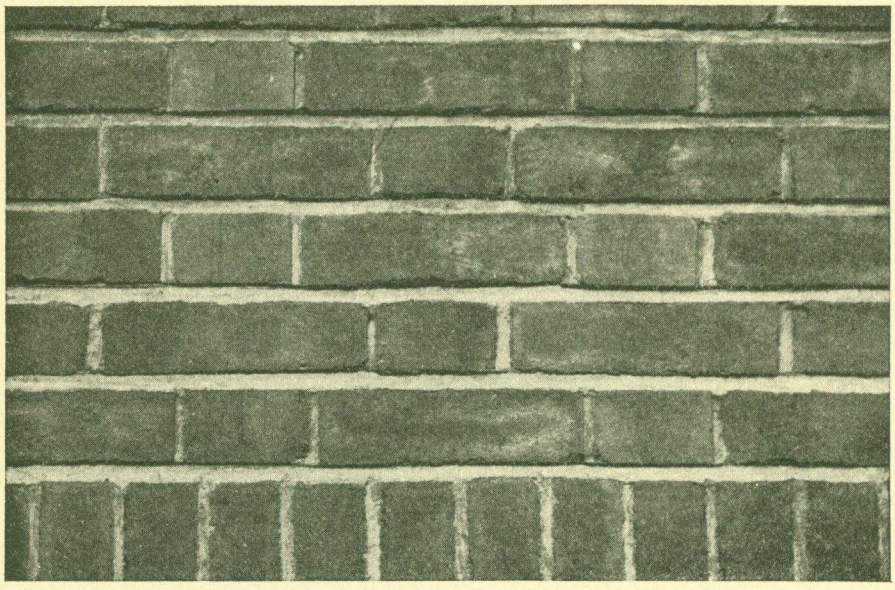


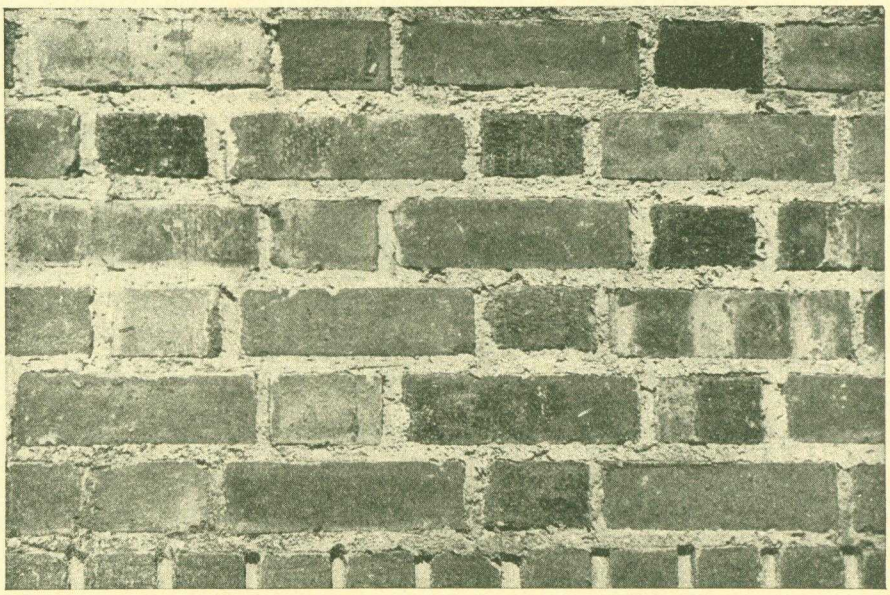
Figure 34. Weathered joint, diagram B. Flemish bond.

Color of Joints:

17. The richness of tone in the individual brick may be brought out and displayed to the best advantage by the proper selection of contrasting effects, which may or may not require the use of color in the joints. No matter what bricks are used, the effect may be spoiled and the wall have a "muddy" appearance if the color or tone of the joints is too near that of the bricks. The joints should be plainly visible, even at a distance. The importance of this cannot be over stated. Note the effect of contrasting mortar and joints in Fig. 21, page 42, and in the illustrations on these pages.

18. Although the slight graduations in the shading of the brick add greatly to the beauty and interest of the finished wall, the color of the mortar joint must be kept even to produce the best effect. Very often natural uncolored mortar will produce excellent

Figure 35. Flush joint, diagram C, Flemish bond.



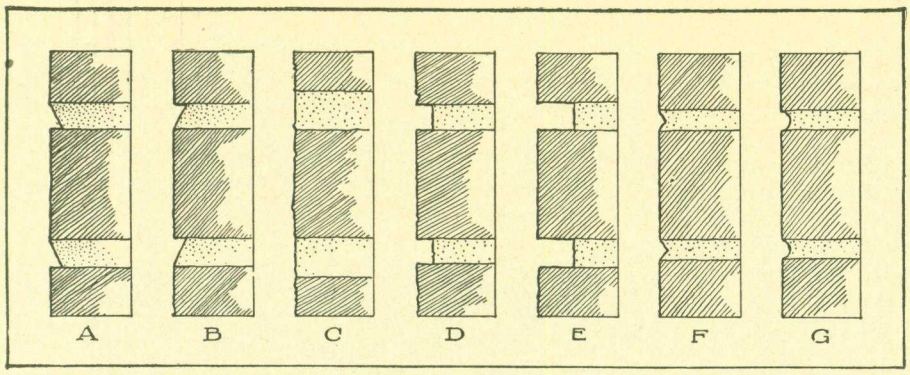


Figure 36. A, struck joint. B, weathered joint. C, flush or plain cut joint D, raked joint E, stripped joint. F, "V" joint. G, concave joint.

results, particularly with a red or darker brick. Strong sunlight will cause any artificial mortar color to fade somewhat.

Section and Texture of Joints:

19. For exposed work the joints are made flush or recessed. With the former, the individual bricks are visible according to the contrast in color and texture between brick and joint. With the latter, the brick outlines are also marked by their shadows.

20. Some designers feel that the texture of the mortar joint should resemble that of the brick, but it is unsafe to lay down hard and fast rules, for charming effects are often produced by a contrast in the texture of brick and joint.

21. A steel jointer or trowel produces a smooth texture, a wood surface being generally used for a rough texture; coarse sand or even fine gravel, if he joint is wide enough, also assisting to form a rough surface.

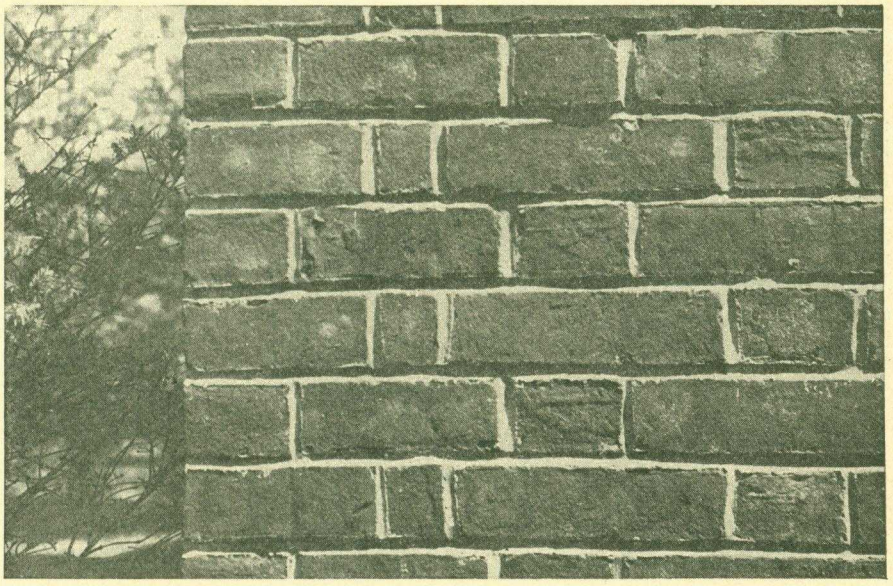


Figure 37. Concave joint, diagram G. Flemish bond, closers at corner. Larger surface with similar joints shown in Fig. 21, page 42.

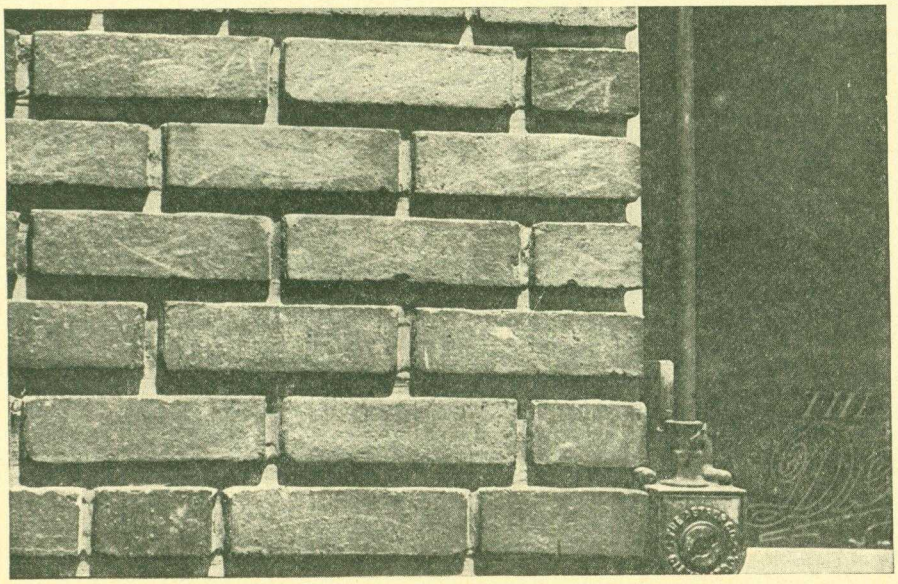


Figure 38. Stripped joint, diagram E, Running bond.

Plain Cut Joints:

22. Used for concealed surfaces and for joints in fire and party walls. Plain cut joints may be used on a basement wall to receive cement damp proofing. Formed by simply cutting off excess mortar with the edge of the trowel.

Struck Joints:

23. Cheapest and most easily formed joint for exterior surfaces. (A, Fig. 36, also Fig. 33.) When well done makes a neat wall. Sometimes objection is made that this joint is not as weather resistive as the weathered joint; but raked joints, which expose much more of the upper surface of the brick, have proved successful and this objection would seem more theoretical than practical.

24. This joint is the most widely used of all for exterior exposed work and for the inside exposed surface of basement walls and other unplastered brick surfaces. It should be used on a basement wall on which asphalt or similar damp proofing is to be mopped.

25. It is formed as a plain cut joint and finished with the trowel as the mortar becomes stiffer.

Weathered Joints:

26. Similar to a struck joint but formed from above with a little more difficulty and costing slightly more. Each course of brick throws a slight shadow. It is difficult to preserve exactly the same slope on the face of the joint. (B, Fig. 36, also Fig. 34.)

Flush Joints:

27. Almost always finished with a rough texture. When used with rough textured brick it is difficult to keep the mortar from the face of the brick. (C. Fig. 36, also Fig. 35.)

28. Formed by cutting off mortar squeezed beyond the face of the wall. The joint must not be manipulated afterwards with the trowel or the cement may be drawn to the surface and the rough texture spoiled. If further treatment is needed the surface may be gently tapped with the end only of a piece of wood having an extremely rough end grain.

Raked Joints:

29. The joint is first plain cut and afterwards raked out to the depth desired, a steel jointer being employed to obtain a smooth texture, a wood stick for a rough texture. (D. Fig. 36.) Corners should be formed square and all excess mortar removed to produce the neatest effect. A cheaper method is to rake the joint quickly and roughly with a stick as the wall is built, brooming out the excess mortar the following day, no attempt being made to produce square corners. This method is often followed by speculative builders. It should not be attempted with rough textured brick.

30. Ideal all-rolok walls may be constructed with raked joints, if the rake is not cut too deeply. A brick on edge has 2¼ in. bearing surface. A ½ in. rake, therefore, will leave 1¾ in. of bearing surface.

Stripped Joints:

31. Produces the neatest and cleanest raked joint and is specially useful with rough textured brick, as it keeps the mortar from the face of the wall. (E. Fig. 36, also Fig. 38, and Fig. 39, page 48.) It is slower and more expensive than raking the joint.

32. A wood strip the thickness of the mortar joint is laid at the front of the wall, set in any depth desired. The bed of mortar is placed behind and flush with the top of the strip and the next course laid, the strip being removed when the mortar has set sufficiently.

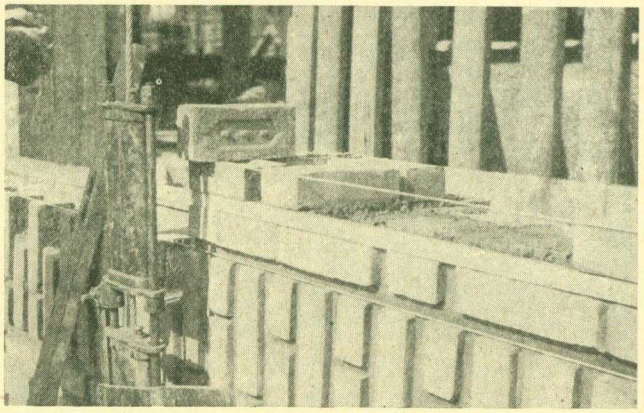
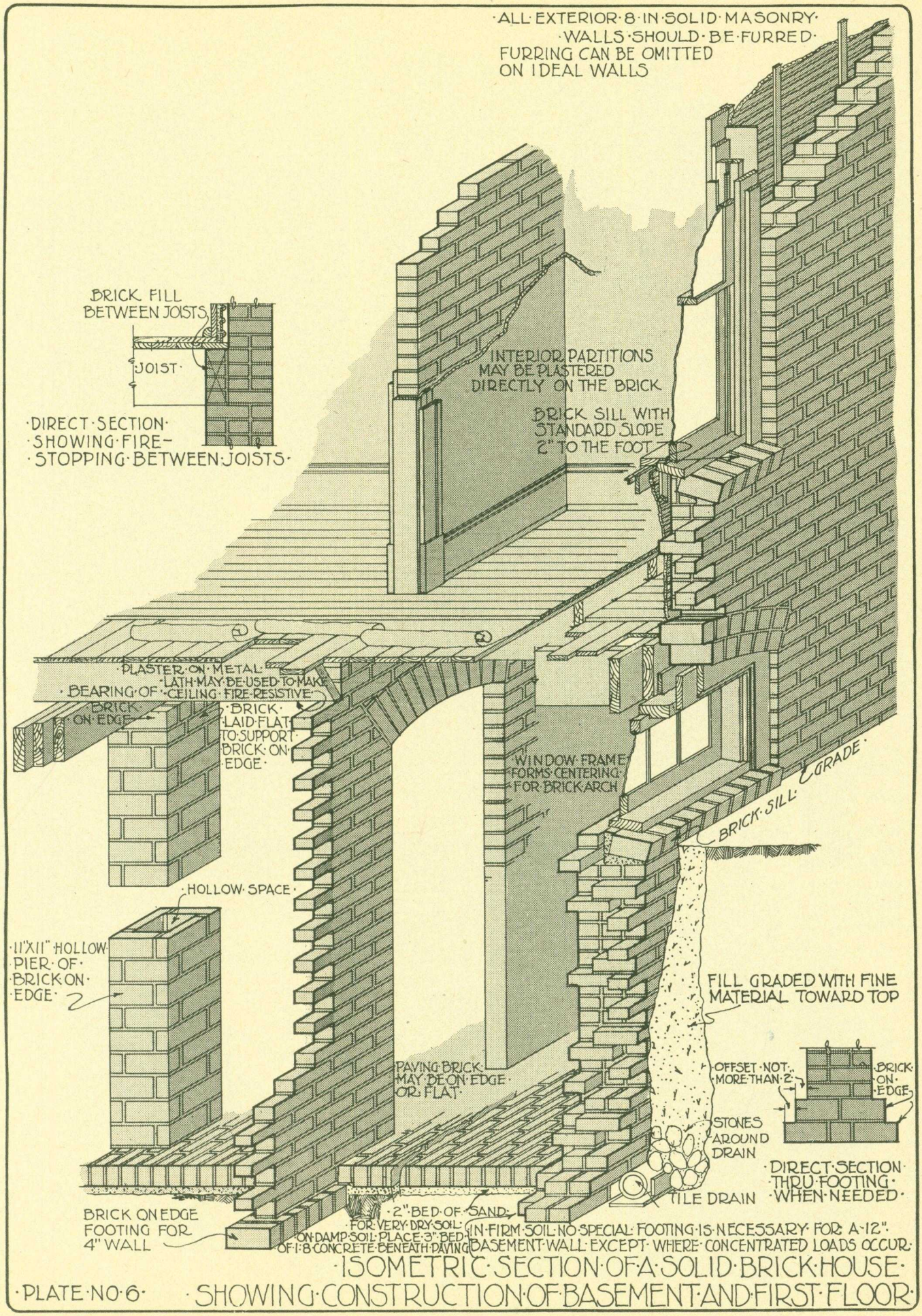


Figure 39. Forming stripped joint. Horizontal course in Double Flemish bond. Note "blind joint" between pairs of stretchers

V Joints and Concave Joints:

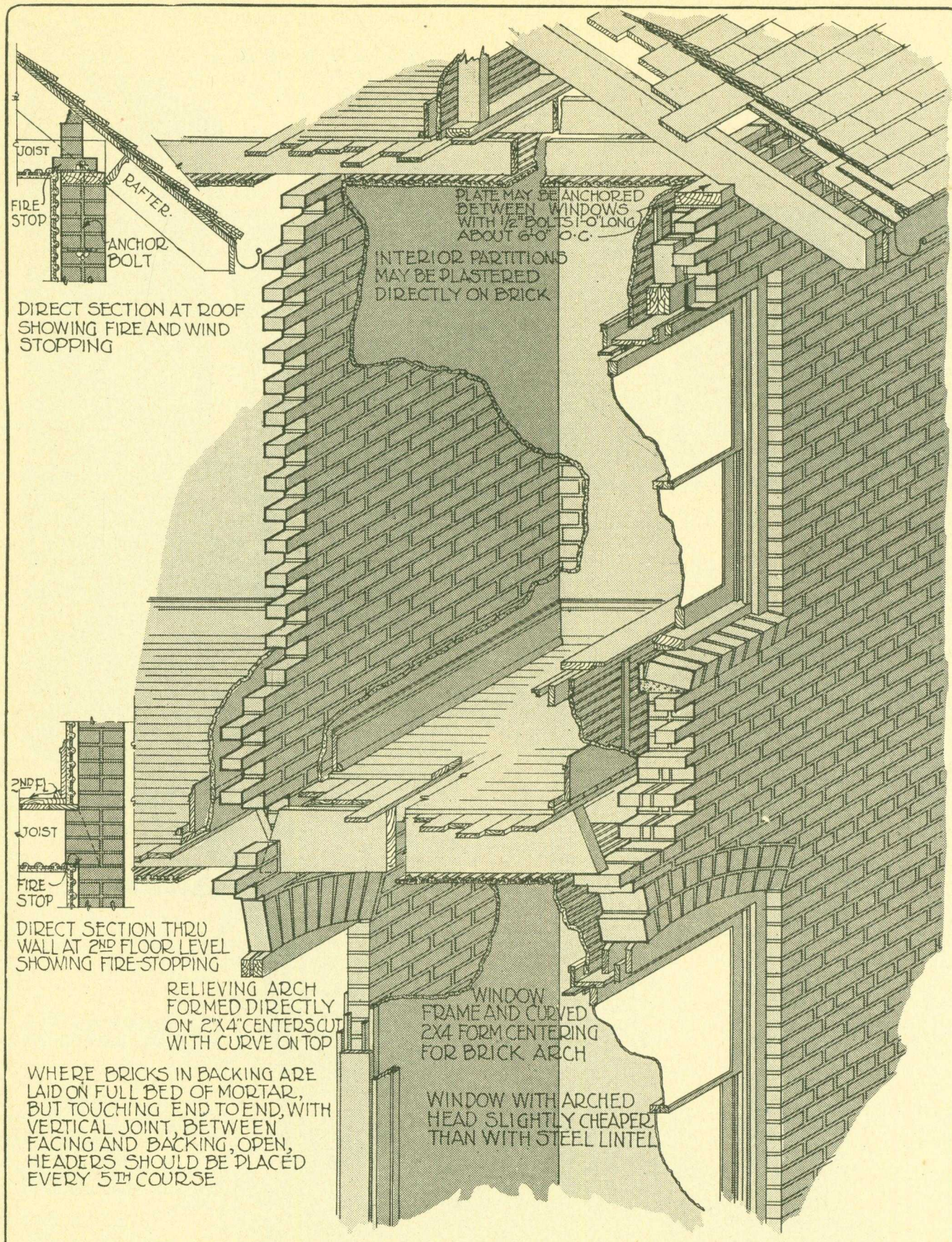
33. Are comparatively inexpensive to form and are weather resistive. (F. and G. Fig. 36, also Fig. 37.) Both are best formed with special tools made for the purpose. A "V" joint may be roughly formed, however, with a square edged board held at an angle and rubbed along the joint and a concave joint may be similarly formed with a board having a rounded edge, or a bent iron rod.

Many of the diagrams and photographs in the chapters on Bonds and Joints are reproduced by the courtesy of the American Face Brick Association and the Builder's Journal.


ALL EXTERIOR 8 IN SOLID MASONRY WALLS SHOULD BE FURRED
FURRING CAN BE OMITTED ON IDEAL WALLS
BRICK FILL BETWEEN JOISTS
JOIST
DIRECT SECTION SHOWING FIRE-STOPPING BETWEEN JOISTS
INTERIOR PARTITIONS MAY BE PLASTERED DIRECTLY ON THE BRICK
BRICK SILL WITH STANDARD SLOPE 2" TO THE FOOT
PLASTER ON METAL LATH MAY BE USED TO MAKE BEARING OF CEILING FIRE-RESISTIVE
BRICK ON EDGE
BRICK LAID FLAT TO SUPPORT BRICK ON EDGE
WINDOW FRAME FORMS CENTERING FOR BRICK ARCH
GRADE
BRICK SILL
HOLLOW SPACE
11"X11" HOLLOW PIER OF BRICK ON EDGE
FILL GRADED WITH FINE MATERIAL TOWARD TOP
PAVING BRICK MAY BE ON EDGE OR FLAT
OFFSET NOT MORE THAN 2"
BRICK ON EDGE
STONES AROUND DRAIN
DIRECT SECTION THRU FOOTING WHEN NEEDED
TILE DRAIN
BRICK ON EDGE FOOTING FOR 4" WALL
2" BED OF SAND FOR VERY DRY SOIL ON DAMP SOIL PLACE 3" BED OF 1:8 CONCRETE BENEATH PAVING
IN FIRM SOIL NO SPECIAL FOOTING IS NECESSARY FOR A 12" BASEMENT WALL EXCEPT WHERE CONCENTRATED LOADS OCCUR

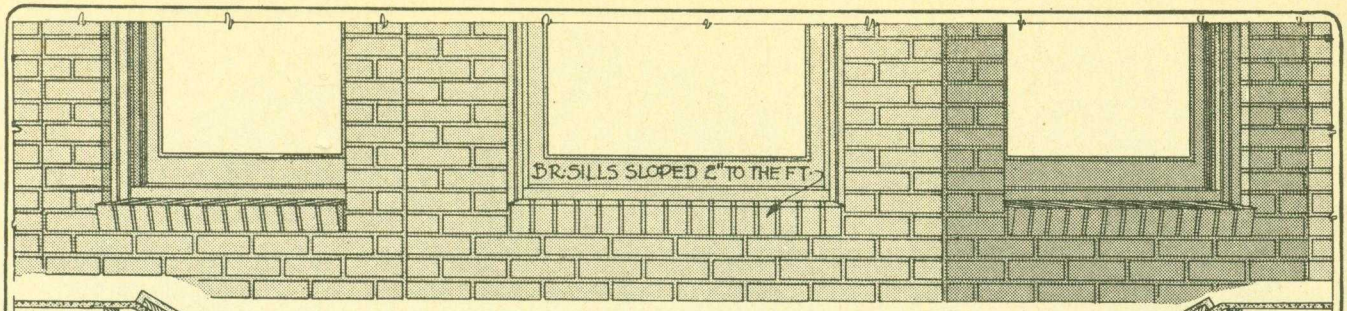
ISOMETRIC SECTION OF A SOLID BRICK HOUSE

PLATE NO 6 · SHOWING CONSTRUCTION OF BASEMENT AND FIRST FLOOR

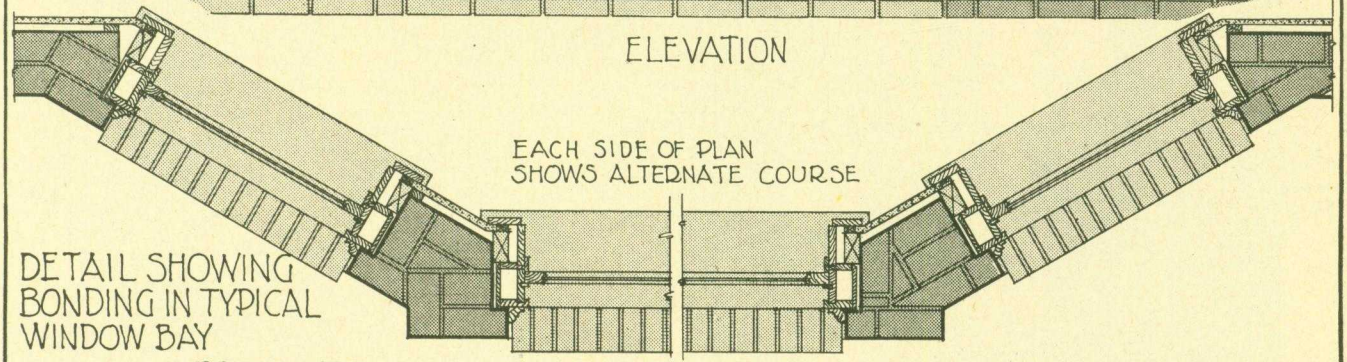

JOIST
FIRE STOP
RAFTER
ANCHOR BOLT
DIRECT SECTION AT ROOF SHOWING FIRE AND WIND STOPPING
PLATE MAY BE ANCHORED BETWEEN WINDOWS WITH 1/2" BOLTS 1'-0" LONG ABOUT 6'-0" O.C.
INTERIOR PARTITIONS MAY BE PLASTERED DIRECTLY ON BRICK
2ND FL
JOIST
FIRE STOP
DIRECT SECTION THRU WALL AT 2ND FLOOR LEVEL SHOWING FIRE-STOPPING
RELIEVING ARCH FORMED DIRECTLY ON 2"X4" CENTERS CUT WITH CURVE ON TOP
WINDOW FRAME AND CURVED 2X4 FORM CENTERING FOR BRICK ARCH
WHERE BRICKS IN BACKING ARE LAID ON FULL BED OF MORTAR, BUT TOUCHING END TO END, WITH VERTICAL JOINT, BETWEEN FACING AND BACKING, OPEN, HEADERS SHOULD BE PLACED EVERY 5TH COURSE
WINDOW WITH ARCHED HEAD SLIGHTLY CHEAPER THAN WITH STEEL LINTEL

·ISOMETRIC·SECTION·SHOWING·CONSTRUCTION· ·OF·A·SOLID·BRICK·HOUSE·UPPER·PART·OF·FIRST· ·FLOOR·SECOND·FLOOR·AND·ROOF·

·PLATE·NO·7·

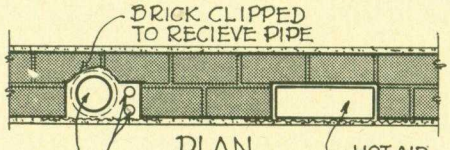


ELEVATION

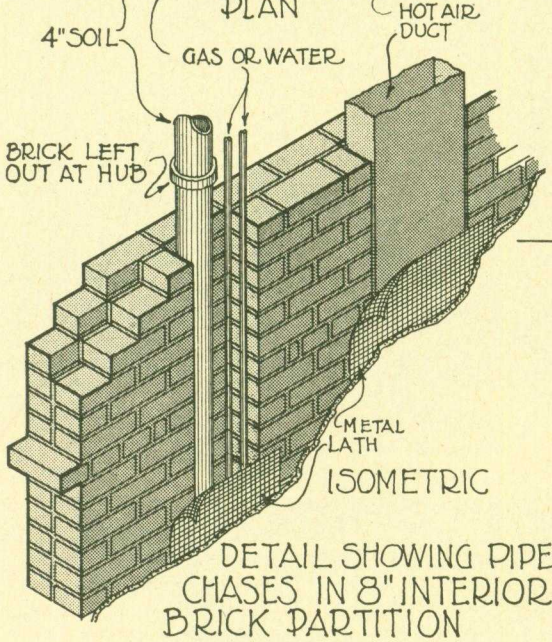


DETAIL SHOWING BONDING IN TYPICAL WINDOW BAY

PLAN

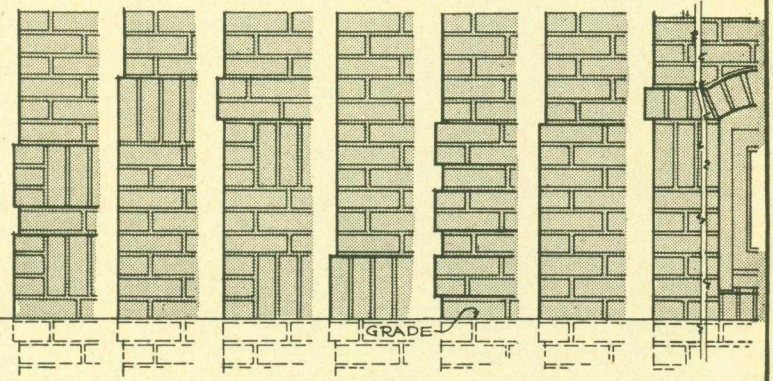


PLAN

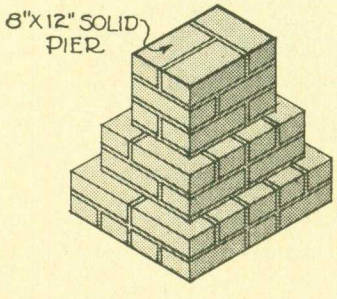


ISOMETRIC

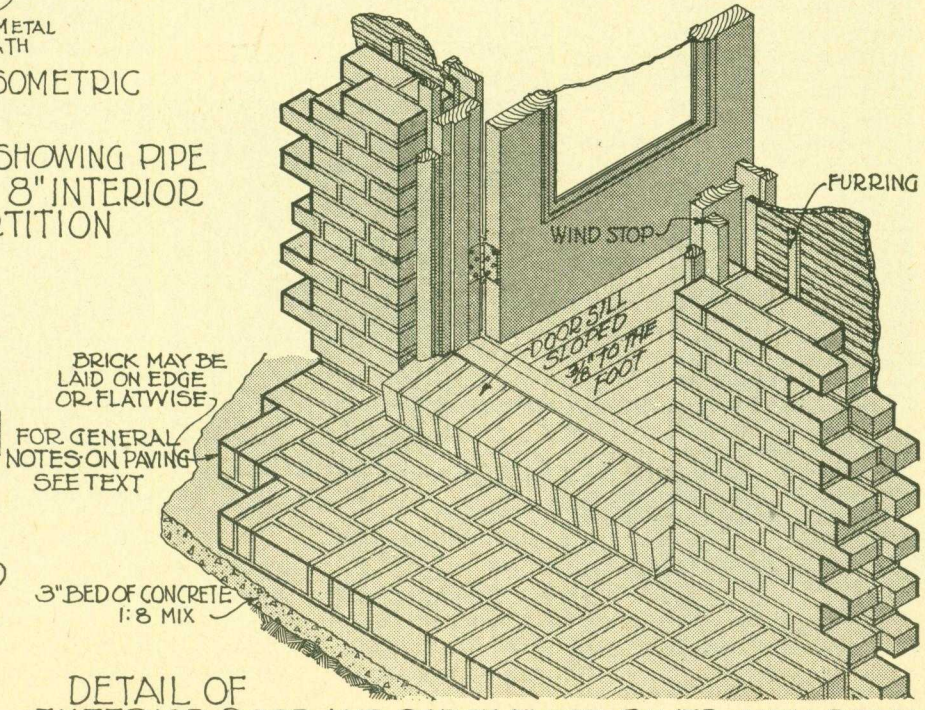
DETAIL SHOWING PIPE CHASES IN 8" INTERIOR BRICK PARTITION



DETAIL SHOWING VARIOUS DESIGNS FOR WATER TABLES

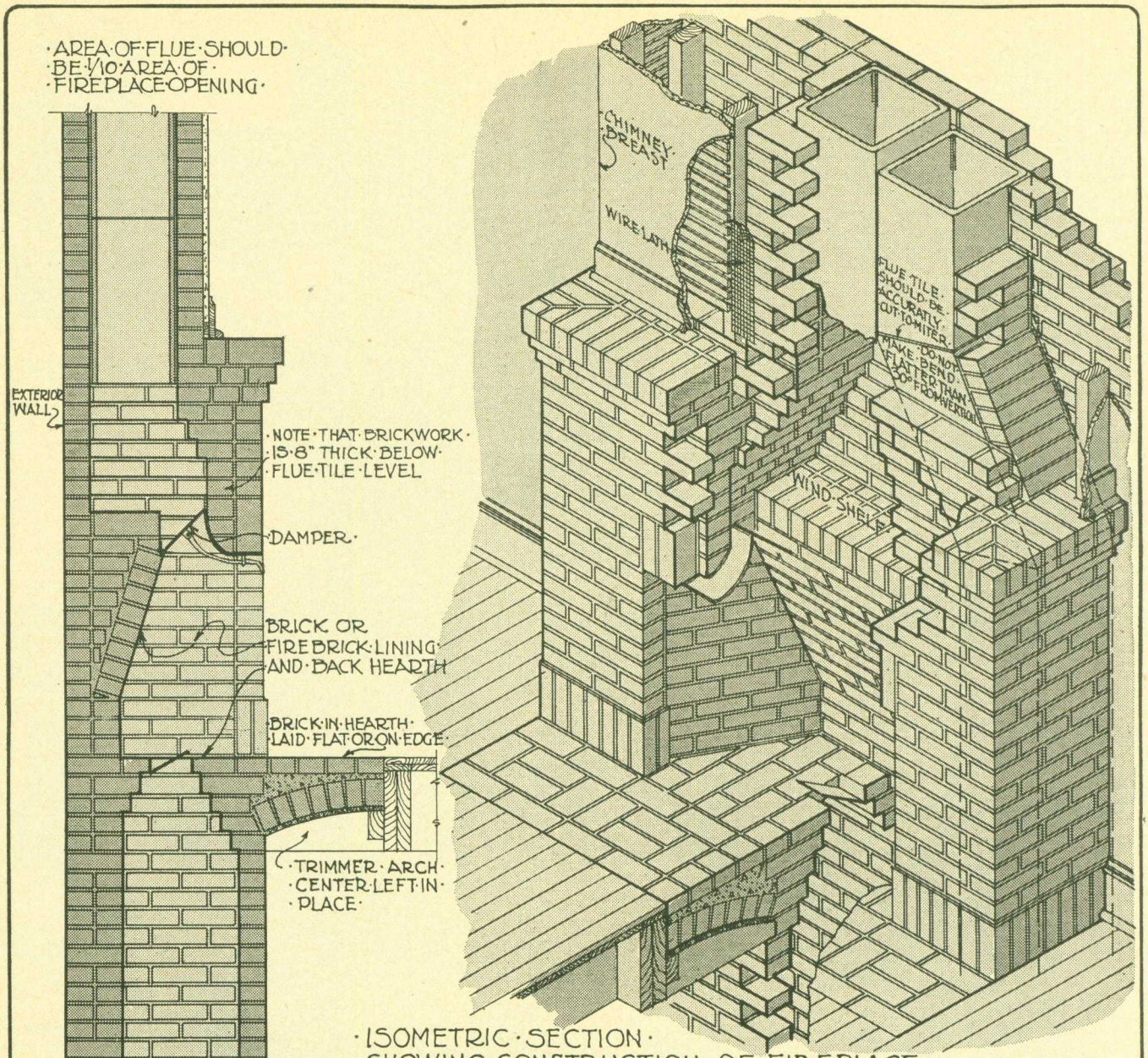


DETAIL SHOWING BOND IN FOOTING UNDER TYPICAL 8"X12" PIER

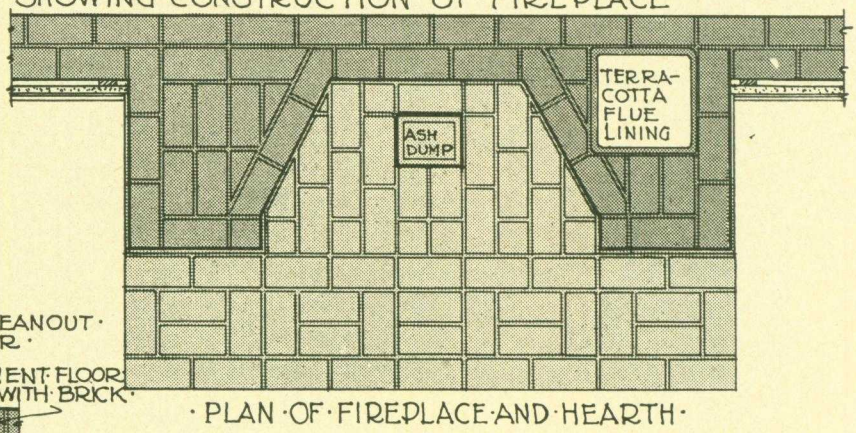

FURRING
WIND STOP
DOOR SILL SLOPED 3/8" TO THE FOOT
BRICK MAY BE LAID ON EDGE OR FLATWISE
FOR GENERAL NOTES ON PAVING SEE TEXT
3" BED OF CONCRETE 1:8 MIX

DETAIL OF EXTERIOR DOOR AND PORCH FLOOR PAVED WITH BRICK

·PLATE·NO·8·


AREA OF FLUE SHOULD BE 1/10 AREA OF FIREPLACE OPENING
EXTERIOR WALL
NOTE THAT BRICKWORK IS 8" THICK BELOW FLUE TILE LEVEL
DAMPER
BRICK OR FIRE BRICK LINING AND BACK HEARTH
BRICK IN HEARTH LAID FLAT OR ON EDGE
TRIMMER ARCH CENTER LEFT IN PLACE
ASH PIT
C. I. CLEANOUT DOOR
BASEMENT FLOOR PAVED WITH BRICK
CHIMNEY BREAST
WIRE LATH
FLUE TILE SHOULD BE ACCURATELY CUT TO MITER
MAKE DO NOT BEND FLATTER THAN 120° FROM VERTICAL
WIND SHELF

ISOMETRIC SECTION SHOWING CONSTRUCTION OF FIREPLACE



PLAN OF FIREPLACE AND HEARTH

SECTION THRU FIREPLACE

DETAILS OF TYPICAL BRICK FIREPLACE AND HEARTH

PLATE NO 9

BRICK RESIDENCE CONSTRUCTION

General:

1. Many points dealing with residence construction have already been covered under various heads in the preceding portion of this book.

Brick Veneer on Frame:

2. In many cases it is possible to materially improve an old frame poperty by veneering it with a shell of 4″ of brickwork. The brickwork undoubtedly adds to the life of the house and "paints" it with an enduring surface which does not have to be renewed. Old frame houses were generally built more sturdily, with larger timbers than frame houses built today, and they with their foundations can often be relied upon to support the veneering.

3. It is a great mistake, however, to construct new buildings of brick veneer on frame. One of the great advantages of brick construction is the permanence and fire resistiveness of its walls, qualitites lacking in brick veneer. Upon a frail support of shrinking 1⅝″ x 3⅝″ studs is placed the heavy duty not only of supporting the dead and live loads of the house, but there is also tied to it a weight of several tons of brickwork built so that its stability is negligible. Especially when a wind is blowing the resulting racking and straining is a tax on the strength of the framework. In a wall of sound construction the entire wall should act as a unit in bearing loads and resisting stresses.

4. A fire starting in a veneered house burns up not only the inside of the house, but the wood part of the outside walls; and the collapse of the brick shell upon the ruins is almost certain. With the brick veneer house the lower insurance rate of the real brick house is forfeited.

5. Brick veneer costs more than a solid or Ideal brick wall in any part of the country. Especially since the advent of the Ideal wall, there are no good reasons for using this thoroughly unsound type of construction, which is both a deception and a snare.

Water Table and String or Belt Courses:

6. The treatment of the brickwork above grade will, of course, depend on the architectural design. The entire wall above the grade may be laid without any special treatment other than the proper proportioning and placing of the windows, the beauty and value of an unbroken surface of brickwork being taken advantage of to the full.

7. Sometimes the proportion and type of the building or the size and disposition of the window openings will make desirable the introduction of horizontal courses to divide the wall surface into two or more bands.

8. Brickwork is often started at the grade line with a simple soldier course, or course of brick on end, or the whole height from grade to first floor line may be specially treated as a water table or plinth. Various types of watertable treatment are illustrated in Plate 8. Suggested types of string course are shown in Fig. 40.

Dividing Work:

9. Always divide off the wall so that each bricklayer will have about the same amount of work to do. This will enable the contractor to pick out the best men. On a wall with few openings bricklayers are placed about 6 feet apart.

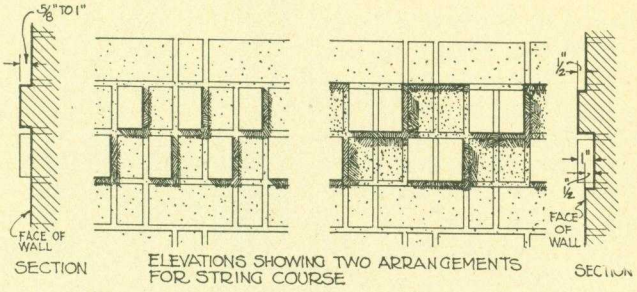


Figure 40. String courses for either solid or Ideal walls.

Wet the Brick Before Laying:

10. It is most important that all brick except impervious brick be wet before being laid, except in freezing weather. The hotter and drier the weather, the more water should be used. If the bricks are not wet, they will absorb the moisture from the mortar, which will interfere with its setting and adhesion to the bricks. On the other hand do not soak the bricks, as they can be made so wet that they will slide on a bed of mortar and this may also thin the mortar so it will run down the face of the wall, making good work difficult.

Handling Brick:

11. Do not allow the brick tenders to throw down the brick on the scaffold so that they scatter or even chip. Care on the part of tenders will save the more valuable time of the bricklayers.

Keep Scaffold Clean:

12. The bricklayer's working space on the scaffold can be kept clean and tidy just as well as not, and by ensuring a good foothold will add to the efficiency of the masons.

13. Every bat or broken brick can and should be used in the wall as the work goes along. No brick should be wasted.

Protect Work at Night:

14. The walls should be protected every night by being covered with boards or other substantial protection to keep off the rain and weather. Boards should have bricks piled on them loosely to prevent the wind blowing them off.

Building the Wall:

15. The bricklayers build the walls from the inside, pointing the face as they go. The most experienced bricklayers are placed at the corners to run up the leads and raise the line. Leads consist of a few courses of brick run up at the corners to which the "trig" and line are attached. The line is generally raised course by course.

Leave Openings and Chases:

16. The location of chimneys, openings and chases shown on the plans or necessary should be carefully noted and all such items taken care of as the wall goes up.

Figure 41. Laying backing, solid construction.

Build in Nailing Blocks and Grounds:

17. When building Ideal walls, build in nailing blocks for the carpenters to attach base and trim. These blocks can be small pieces of 2″ x 4″.

18. For attaching furring strips to solid walls build in plasterers lath in the joints about every seventh course, well backed with mortar and slightly projecting; always break joints of lath.

Footings:

19. A residence foundation wall 12 in. thick built upon firm ground will not require a footing in the majority of cases, except where concentrated loads occur. Where a footing is deemed necessary it may either be composed of concrete poured into a trench or built expeditiously of hard burned brick in cement mortar. The footing for a 4″ interior partition may be 8″ wide, consisting of a header course on edge.

20. Projections are formed by stepping off each course or every other course about 2″, the projections being formed of a continuous course of headers. Projections should be equal on both sides of the wall. It is recommended that projecting courses be formed of brick on edge, these being capable of resisting a greater transverse strain than flat courses.

21. The excavation should be carefully levelled and the first course laid on cement mortar spread upon the ground.

22. Footings or walls without footings must always be taken below the frost line. Don't give the frost any chance to heave up walls or footings, porch walls included.

23. No part of the building is more important than the foundation. If there is the least doubt regarding the firmness of the soil, the excavation should be carried down to firmer ground, and the footing made wider by stepping off with more courses. Never place a wall on filled ground or spongy, springy soil.

24. If stone is encountered during excavation, of suitable character for footings or foundation walls, it may be economical to use it instead of brick below ground.

Drain at Footings:

25. It is advisable in almost all cases to place a porous tile drain at the bottom of the wall or at the footings to carry off any water which may accumulate. This drain should be laid with an even slope, the high point not above the floor level and the low point not below the bottom of the wall or footing.

26. The best way to avoid dips and traps in the drain is to lay it on a board with a strip nailed at the side to hold it in place laterally. The fill over the tile should be of dry material such as large stones or broken brick placed carefully on the tile—not dumped from a wheelbarrow—and the finer fill graded toward the top. The tile should be connected with the cellar floor or surface water drainage system.

Damp Proofing Basement Walls:

27. Except in extremely dry soils it is much safer to damp proof the basement walls, and this should always be placed on the outside of the wall.

28. To resist ordinary dampness the best damp-proofing is considered by many to consist of asphalt thoroughly well mopped boiling hot directly on the brick wall, which should be laid with struck joints. A mixture of three parts tar and one of pitch is sometimes used, and forms an excellent low cost damp-proofing. Tar alone is sometimes employed but soon becomes brittle and flakes off. A one-half inch coat of cement plaster is sometimes used, but is probably not as effective or reliable as mopping the wall as described.

29. If the soil is actually wet, the wall may be waterproofed by first mopping it thoroughly with boiling hot asphalt, and then applying one or two thicknesses of felt, with asphalt mopped between each ply and over the last ply. This treatment is expensive and need only be applied where water is actually present in the soil.

30. In very wet soils it is also advisable in some cases to waterproof the top of the footing to prevent moisture rising in the wall by capillary attraction. Two courses of slate, laid to break joint, or a strip of composition roofing will answer this purpose. As a further protection, a similar course may also be laid about 6″ above the grade line.

31. Coating 1000 square feet of brick wall with asphalt requires:—200 pounds hot asphalt, 4 hours attending fire and 4 hours mopping wall. A boiler will be required for heating the asphalt.

32. Cement plaster for damp-proofing the outside of basement walls below grade should be composed of one part Portland cement to two parts very coarse sand. (Par. 4, page 37.) The finish should be compactly troweled fairly smooth, but need not be floated.

33. The following quantity of material is necessary to cover 100 square feet of brick with plaster ½ inch thick:—2 bags Portland cement, 4 cubic feet sand, laborers time mixing plaster ½ hour.

34. An experienced man and good helper should cover 42 square feet of surface per hour.

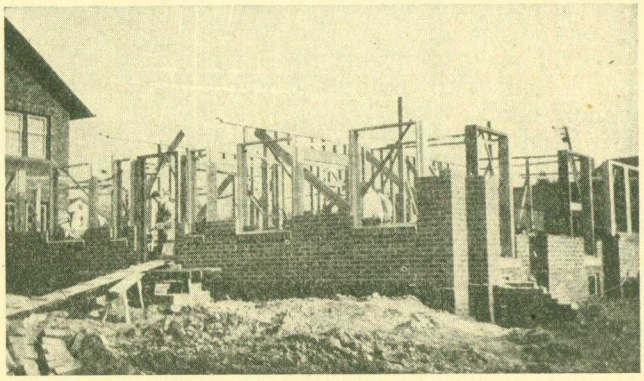


Figure 42. A typical solid brick operation.

Basement Piers:

35. If local ordinances permit, basement piers may be economically built hollow with brick on edge, as shown in Plate 6. See tests of these piers, Table 8, page 30. See also pars. 14-17, page 9.

Joist Support:

36. In brickwork, the courses can easily be adjusted so that the courses supporting joists will be at the exact height required. No "shims" or blocking under the joists are needed or should be allowed.

37. Joists and timbers should be set directly on the brick, unless their bearing surface is so small that they transmit a load over the safe bearing capacity of the wall, which occurs very seldom, but which would require bearing plates.

38. Never use wood bonding timbers. They will shrink and seriously weaken any wall.

Floor and Roof Anchors:

39. In the better class of residence work floor joists and roof plates are anchored to the walls. Some cities require this by ordinance. In the great majority of speculative residence work outside of such cities, however, anchors are not used. Anchors are spaced approximately six feet apart both for floor joists and roof plate. Where joists run parallel to the wall the anchor straps are made long enough to be attached to about three joists, into which they are mortised on top. Anchors as illustrated in Figs. 13 and 14, page 16, can be placed in either solid or Ideal walls.

40. When the joists are at right angles to the wall, anchors should be placed near the bottom of the joist to lessen the strain on the wall in case the joist burns away and drops out.

41. Roof plate anchors are built in as the wall nears that level. They are generally half inch bolts with a washer at the bottom and a nut and washer at the top.

Joists:

42. Joists with square ends should not be placed in a masonry wall, but the ends should be splayed or "fire cut" as shown in the plates. This enables the joist to drop out easily in case of fire without damaging the masonry.

43. A narrow space should be left on each side and at the end of every joist to allow the air to circulate around it and tend to prevent dry rot.

Fire Stopping:

44. Every wall should be firestopped at each story so that fire cannot spread through openings from floor to floor. Methods of firestopping unfurred Ideal walls have already been described.

45. Where a furred wall is offset from a thicker to a thinner wall, beam filling should be placed between the joists to the sub-floor level. Where the furred wall is the same thickness above and below the joists, the inside face of the wall should be corbelled* out two inches for the entire depth of the joist. The full thickness over the top of furring and plaster on the wall below should be capped, and the full thickness of the furring and plaster of the wall above should have brickwork beneath it. In each case openings should be closed tightly.

46. Brick filling formed in cement should also be placed between the rafters above the roof plate and the slope of the roof sheathing. This acts as a windstop, and makes the house more comfortable in winter, as well as saving coal. This filling need not be more than 4″ thick.

Window and Door Sills:

47. Brick, terra cotta, or stone window sills should be used in a brick building. Cement sills poured in place or wood sills are not well adapted for this purpose, nor are they sightly or permanent. Stone window or door sills should be of such thickness that they line with the courses of brick, with a lug at each end.

48. Brick sills are the least inexpensive. The brick are laid on edge and sloped forward, with the bottom edge projecting about an inch to form a drip. The standard slope is 2″ to the foot.

49. To line the edge of the sill accurately a plank should be fastened to the wall and the brick placed upon it, as shown in Fig. 43, which shows also the way each brick is "buttered" with mortar before being pressed into place, 1:3 or, preferably, 1:2 cement mortar should be used. While the illustration shows a brick sill being placed under a steel frame after the latter is set, it is better construction to set the sill first. The latter should always be done with a wood frame.

50. To obtain the best effect, brick sills should be "slip sills," not wider than the actual masonry opening. Brick sills laid horizontally with a pitch formed with cement are not satisfactory, as the action of the weather may cause the cement to loosen.

51. In general, brick is the most satisfactory material for either window or door sills, although it may be made to form charming combinations with other materials. Where brick is used throughout, however, no material has to be specially ordered.

52. Brick is beautiful and flexible. An appearance of great solidity may be gained by sloping the brick window sills very sharply, thus apparently increasing the depth of the reveal of the windows.

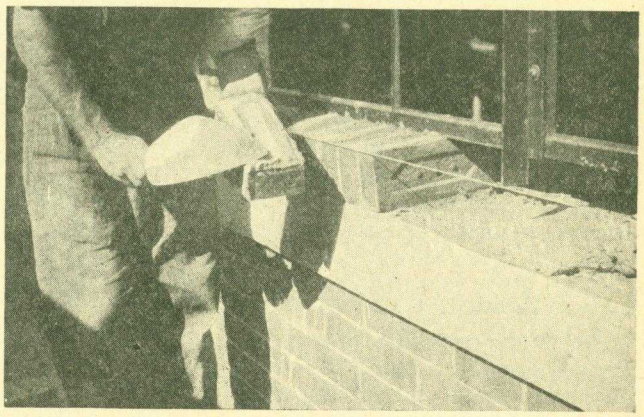


Figure 43. Laying brick sill. Note board on which brick are lined.

53. Brick for door sills should be hard burned. The standard slope for brick door sills is 3/8″ to the foot.

*Corbel. Masonry projecting beyond the normal face of the wall. Used as a support, ornamental feature, firestopping, or for other purposes.

Window and Door Frames:

54. The only difference between double hung windows for frame and for brick walls is that the latter are boxed in at the jambs to provide a housing for the weights and that they have a staff bead outside. It is cheaper, however, to buy stock frames for brick walls with the box in place than to have the carpenter on the job make the box.

55. Frames should always be constructed so that there is no straight joint at the back of the frame from front to back of the wall. A "windstop" should be nailed on all such frames so that shrinkage of the frame will not allow drafts to blow through into the house.

56. Window and door frames for brick walls are made by all millwork companies. The Curtis Companies and their dealers carry a standardized line, particulars of which they will send on application. We suggest that contractors use standard sizes wherever possible. Frames of any size can, of course, be used with brick walls, the small brick units and numerous courses making adjustment easy to any dimension.

Setting Window and Door Frames:

57. Window and door frames are set by the carpenter, window frames being placed on top of the sill on a thin bed of mortar. A much better job is made if they are set before the wall has risen above the sill level. They are levelled, plumbed, and braced so that the braces will not interfere with the placing of the scaffold.

58. First floor frames are sometimes braced to stakes driven in the ground outside the house. The most convenient way, however, is to place an upright at about the centre of a small house, braced in two directions near the bottom with short pieces of plank. All the window frames on the story are then braced to the upright with braces placed horizontally, near the top of the frame, sloping braces being entirely avoided. This provides clear working space under the braces and scaffolding can be moved around at will. (Fig. 44.)

59. The carpenter should pile a few brick on the sill to assist in holding the frame steady. If he fails to do this, the bricklayer should place them himself before starting to brick the window in.

60. If a door frame or casement window frame is high a cross piece should be nailed on the frame to prevent the window being lowed in. The box stiffens a double hung frame considerably.

61. The openings for interior frames are generally formed in brick and the frames set afterwards.

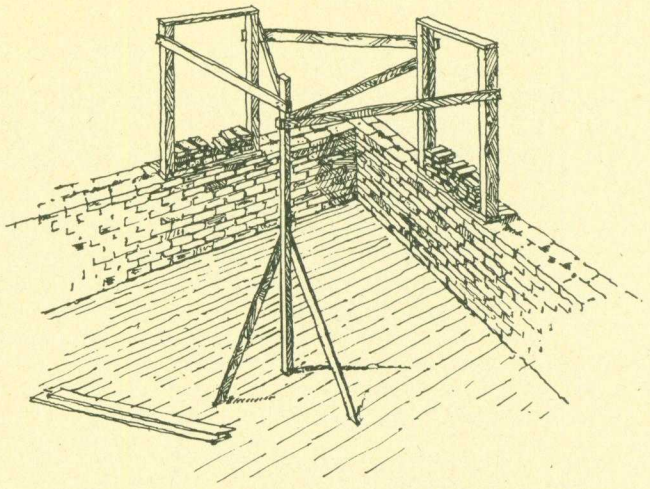
Labor Setting Window and Door Frames:

62. No more time is required to set window or door frames in a brick than in a frame house. The carpenter does the setting and bracing, the bricklayer simply bricks them in.

63. Setting, bracing, and plumbing a single, double or triple window frame or door frame requires from 25 to 30 minutes carpenters time.

Supports Over Openings:

64. Formed by arches of various types or by lintels. Over window and door frames, the brickwork the depth of the reveal is carried on the face arch or lintel, the backing carried on another lintel set higher than the face support, with or without a relieving arch above it. Where openings are arched, however,



METHOD OF BRACING WINDOW FRAMES TO ALLOW ROOM FOR SCAFFOLD BENEATH BRACES

Figure 44.

a less expensive and more general method is to run the arch the full thickness of the 8″ wall, and this method is shown on the plates. It has the disadvantage, however, of not providing such a good windbreak as the method first described.

65. In a small house, flat or practically flat lintels or arches over openings are to be preferred for the sake of appearance. The effect of a segmental arch is to increase the apparent size of the opening, and this may tend to throw it out of scale with the building.

66. A stone lintel should not be relied upon to sustain the load of the wall above. It is safer to support the stone with steel. Stone has uncertain transverse strength and may crack unless made too high for good proportion. A small mould of appropriate section over the top and at the sides of a stone lintel will produce a better effect than a flat lintel set flush with the brick wall, particularly where the lintel is three or more brick courses high. Do not use stone which contrasts too strongly in effect with the brickwork or the elevation may be restless and "spotty."

Rough Support of Backing:

67. Over a door or window opening the brick backing may be carried on a wood lintel. This is all the support required for backing over openings three feet wide and less; for when the mortar is set, brickwork will support itself over spans of this width, even though the wood lintel should burn or decay. For openings wider than three feet, a brick relieving arch should be thrown over the lintel, bearing on the wall at the ends of the lintel and not on the lintel itself. The space between the lintel and relieving arch should be filled with brickwork. This is built upon the lintel and shaped at the top to form a centre for the relieving arch.

Steel Lintels:

68. Where a flat soffit is desired a simple steel lintel may be used to support the outside thickness of brickwork over an opening with a 4″ reveal. A 4″ x 3″ or even 3″ x 3″ steel angle is generally sufficient for openings up to 4 feet wide, wider openings up to 5 feet require a 3″ x 5″ angle. If the reveal is 8″, two angles back to back should be used, preferably riveted together.

69. If both sides of the wall are exposed the whole thickness should be carried upon the steel.

70. If the floor joists above are close to the top of the opening below, care should be taken that the lintels are strong enough to carry them.

Painting Steel Angles:

71. Before setting the angles, the surface and ends which will be buried and concealed in the masonry should first be thoroughly painted with graphite or red lead and oil.

Soldier Course Over Angles:

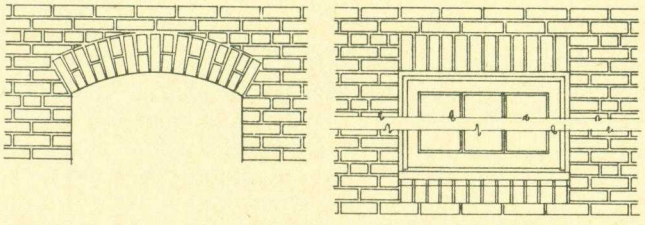
72. A soldier course of brick on end is frequently placed over a steel lintel. Very often the mistake is made of making this course wider than the opening. A much better effect will be gained by making it no longer than the width of the opening, similar to the brick on edge "slip sill" already mentioned.

Bearing of Lintels:

73. Wood or steel lintels should generally be made 8 in. longer than the openings, giving 4 in. bearing at each end.

Types of Brick Arches:

74. Flat, segmental, semi-circular and elliptical arches are commonly used. In the latter type a more pleasing outline may be obtained by laying out the curve freehand than by using a true ellipse constructed mechanically. A true ellipse has too great a radius at the spring line.



SEGMENTAL ARCH WITH ALTERNATE HEADERS AND STRETCHERS

ELEVATION OF WINDOW WITH BRICK SILL AND SOLDIER COURSE OVER STEEL LINTEL

Figure 45.

The Flat Arch:

75. Although, in theory, a flat or "jack" arch is a true arch, capable of bearing a load, in practice it is weak and should be supported on steel if the opening is over two feet wide. The steel should of course be bent to the camber, if any, of the soffit.*

76. If the very best effect is desired, jack arches should be constructed so that the radial joints are the same width for the whole length of the joint.

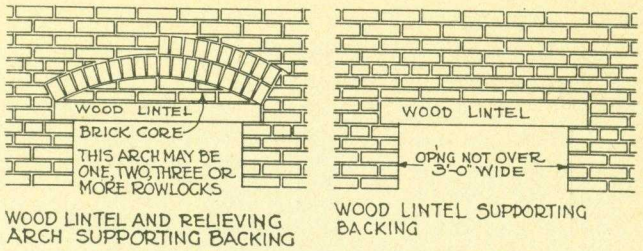

WOOD LINTEL
BRICK CORE
THIS ARCH MAY BE ONE, TWO, THREE OR MORE ROWLOCKS
WOOD LINTEL AND RELIEVING ARCH SUPPORTING BACKING
WOOD LINTEL
OPNG NOT OVER 3'-0" WIDE
WOOD LINTEL SUPPORTING BACKING

Figure 46.

To make a perfect job either special brick must be made or the bricks rubbed to a wedge shape. Either of these methods is, of course, expensive.

77. The brick should also be shaped so that the joints at the ends of the brick within the arch are horizontal, instead of at right angles to the radius of the arch. (Fig. 47 and Fig 21, page 42.)

78. Inasmuch as a perfectly horizontal soffit, especially a wide one, appears to the eye to sag in the middle, a slight camber may be formed in the soffit to correct this.

Segmental and Semi-Circular Arches:

79. The strongest type of arch is the segmental, where the abutment is ample to resist the thrust. With small abutments the semi-circular arch is safer.

80. For openings over windows and doors in residences the segmental arch is the type almost always used. The rise of a segmental arch will, of course, depend on the architectural design. A good rule to follow, however, is to make the rise equal to one-eighth the width of the opening.

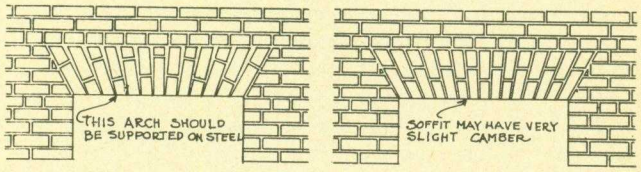

THIS ARCH SHOULD BE SUPPORTED ON STEEL
INEXPENSIVE TYPE OF FLAT OR "JACK" ARCH. BRICKS NOT RUBBED TO WEDGE SHAPE HORIZONTAL JOINTS AT RIGHT ANGLES TO RADIUS OF BRICK. BRICK RUBBED AT SOFFIT AND TOP ONLY
SOFFIT MAY HAVE VERY SLIGHT CAMBER
BETTER TYPE OF FLAT OR "JACK" ARCH. BRICK RUBBED TO WEDGE SHAPE AND RUBBED TO FORM HORIZONTAL JOINTS TOP AND BOTTOM OF EACH BRICK.

Figure 47.

81. For relieving arches and for arches in basements the rise from spring line to soffit may be made one inch for every foot of opening.

82. In the very best work, the bricks in segmental arches where rowlocks are 9″ wide are rubbed to wedge shape, but for ordinary residence work the curve is taken up in the joints, by making them wider at the top than the bottom. Bricks are sometimes chipped to wedge shape by the bricklayer.

83. The strongest arches are bonded by headers, as in the case of a brick wall.

Centering:

84. Centering for arches is furnished, set, and struck by the carpenter.

85. Over windows and doors having a 4″ reveal, the face arch may be constructed without centering; the window frames with the staff bead in place furnishing sufficient support.

*Soffit. An under surface.

Cost of Supports Over Openings:

86. For ordinary residence work with 4″ reveals to windows and doors the segmental arch is the lowest in cost. A flat steel lintel with or without a soldier course on top costs a little more than a segmental arch but may present a better appearance, depending on the design.

87. Segmental face and relieving arches set in 4″ rowlocks, and soldier courses over steel lintels, take practically no more time to set than the brick in the rest of the wall, and nothing extra should be figured for them.

88. Where brick are roughly chipped to wedge shape the cost of the chipping only should be added. A bricklayer can chip about 40 brick per hour.

Brickwork Carried by Arch or Lintel:

89. It should not be assumed that a strip of brickwork to the top of the wall, the same width as the opening, is carried by the support. Brickwork tends to arch itself over. A section of brickwork forming an equilateral triangle, each side having the same length as the width of the opening, should be assumed to be carried by the support. The weight of any floor construction within or near the top of this area should, of course, be added.

Pipes in Brick Walls:

90. Electric conduits, gas pipes, and small water pipes may be built within a solid wall as it goes up, and they can easily be placed in a sloping position in Ideal walls after the latter are built.

91. Four inch soil pipes may be brought down and concealed in an 8″ solid or Ideal interior brick wall. These pipes measure 6 inches over the hubs.

92. The method employed for a solid wall is to leave a chase 4½ inches deep where the soil is to be placed. When the plumber is ready to "rough in" his work, a small section of brick about 2½ inches wide and 1 inch deep is chipped out from the back of the chase behind the exact location of the pipe unless the wall is to be furred or stripped, when no chipping is required. Where the hub of the pipe occurs one brick may be taken out entirely. Gas and water pipes may also be run in these chases. The open side of the chase is covered with wire lath and plastered with the rest of the wall. The holes on the other side of the wall, where brick were removed at the pipe hubs, should also be covered with wire lath. (Plate 8.)

93. In an Ideal all-rolok wall the 4″ soil pipe will fit the hollow space with a little chipping, a brick being left out at the hubs.

94. Soil and water pipes should always be placed within interior partitions to lessen liability of freezing.

Duct Chases:

95. Hot air ducts may also be set in 8″ solid or Ideal walls. Leave a chase slightly wider than the width of the tin ducts, and after the duct is set cover with wire lath. (Plate 8.) Ducts run in brick walls do not need to be covered with asbestos. As with plumbing pipes, heat ducts should never be run in outside walls.

Bay Windows:

96. There are many ways of building bay windows in brick. The example shown on Plate 8 illustrates one method for a solid wall by which cutting the brick at the corners is reduced to a minimum, while presenting a very neat appearance. Each half of the plan shows an alternate course of brick.

Furring:

97. For data on omission of furring on Ideal walls see par. 15, page 11.

98. Under favorable conditions in some localities plaster may be applied directly to the inside of 8″ solid brick walls. A house built several years ago in northern Iowa with walls 8″ thick laid with impervious face brick is plastered inside directly on the brick without any ill effect being noted. Generally speaking, however, it is safer to furr the inside of any ordinary exterior 8″ masonry wall.

99. Furring may be of wood, metal, or hollow tile.

100. Wood is ordinarily used, formed of 1″ x 2″ strips placed vertically, spaced 16″ on centre. In the cheapest work the strips are nailed into dry mortar joints, in better work to lath placed by the masons in the joints, or the walls may be plugged with wood plugs left projecting, and sawed off so that the strips will lie in an even plane, thus correcting any irregularities in the surface of the wall. Nailing to lath or to plugs also makes a more secure job than nailing into brick joints. The strips should be trued up where necessary by wedging behind them. Recent investigations show that furring strips placed horizontally will conserve heat in cold weather and also make effectual firestops.

101. Split furring tile 3″ or 4″ thick, which are scored so that they can be split in half, are sometimes used. The tile is set without mortar and anchored at every second course by driving ten penny nails into the mortar joints over every third tile. Tile provides a good surface upon which to plaster.

102. Metal furring is employed when metal lath is used and may consist of small steel rods or stiffening members in the metal lath itself.

Labor Cost of Wood Furring:

103. On an ordinary job furred with strips nailed to lath or directly into dry joints, a carpenter should place about 80 lineal feet of wood furring strips per hour or 640 lineal feet per day. He should plug the wall and place about 30 lineal feet of furring per hour or 240 feet per 8 hour day.

Basement Paving:

104. If the soil is firm and dry, basement paving may consist of brick on edge or flat laid upon a bed of sand not less than 2 in. thick. The sand is tamped or rolled level and the joints afterwards carefully poured full of cement grout, the brick being wiped clean before grout has set. Another method is to sweep the joints full of cement grout with a broom. Methods of laying brick walks and steps apply also in general to basement paving. (Pars. 3 to 16, pages 64 and 65.) A cheaper method even than this is to sweep the joints full of sand as described for

garden walks. Salt should be mixed generously with the sand to eliminate all danger of vegetation appearing between the joints. If the soil is not firm, however, the floor laid by either of the foregoing methods may become irregular in time. If there is any doubt about the firmness of the soil or if it is not quite dry, place a 3" bed of lean 1:8 concrete under the floor with the brick wearing surface on top. (Plate 8.)

Number of Bricks in Basement Paving:

105. Figure the area of the paving in square feet. If brick are on edge read number of brick required from Table, 28 page 71. If laid flat, figure 4 brick per sq. ft.

106. Allow 1½ cubic feet sand to every square yard paving for cushion 2 inches thick.

Grout for Basement Paving:

107. Grout should be mixed in the proportion of one part Portland cement to 3 parts sand, made thin so it will run down and fill the entire joint. Approximately 3 bags cement and ⅓ cubic yard sand are required for every 1000 brick laid with joints 3/16" to ¼" wide.

Laying Brick Paving:

108. A laborer will spread, level and tamp 125 square feet sand cushion 2 inches thick per hour.

109. A bricklayer laying brick on edge should lay all the paving brick in the basement of any house of moderate size in about half an 8 hour day, leaving the joints open for filling with cement grout or sand. Laborers time handling brick and helping mason about 10 hours.

110. One laborer can grout 70 to 80 square feet of brick flooring, sweeping it in with a broom, in one hour.

Cleaning Brickwork:

111. All exposed brick should be scrubbed soon after completion with water and not more than 5% by volume muriatic acid or about one pint to four gallons of water. A stronger solution may injure the wall. Afterwards scrub thoroughly with clean water to remove the acid.

112. A man should cover about 95 square feet of brickwork per hour.

Vaulted Wall Construction:

113. A type of hollow wall construction much used in some localities on this continent and very frequently in Europe, consists of two walls of brick laid flat, separated by a two inch air space and connected with metal ties. In this country the wall is generally constructed with a total thickness of ten inches. A fourteen inch thickness is sometimes employed. This wall is an excellent type of construction for residences but costs more than the eight inch Ideal or solid wall and cannot be as strong as either of these types; also the metal ties will be apt to rust away in time.

114. This wall is built upon the same basic principle of the ventilated air space as the Ideal wall and its invariable success is but another proof of the soundness of this principle.

115. Furring is not required with a ten inch wall of this construction, except under the same limitations for intensely cold climates as described for the Ideal wall.

116. Fire stops are not required with this wall.

FIREPLACES AND CHIMNEYS

Material for Chimneys:

1. Solid brickwork is the safest and most satisfactory material to use for chimneys and flues. If a chimney fire occurs considerable heat may be engendered in the chimney, and the safety of the house will then depend upon the integrity of the flue wall. It is dangerous to use hollow units for this purpose, for these cannot stand high temperatures without danger of cracking and spalling. See also pars. 12-13, page 33. Salmon brick may be used for chimneys below the roof line.

The Brick Fireplace:

2. The comfort and pleasure of a home may be vastly increased by a fireplace in the living room and the most appropriate and the safest material of which to build, both the fireplace and mantel, is brick.*

Location:

3. A fireplace is the outstanding feature of any room in which it is placed. Furniture is arranged with the fireplace as the starting point and the latter should, therefore, be in the natural focal point, as it were, of the room. It should thus be placed at the narrow end of the room, out of line of travel and away from the entrance. A fireplace looks awkward and tends to dwarf the room when placed on its broad side. Moreover, the hearth will project so far that it will cause difficulty in placing the rug.

Efficiency:

4. Properly constructed, a fireplace will aid greatly in heating the room. Poorly constructed, most of the heat will go up the chimney.

5. To obtain the greatest efficiency, the heated gases should be made to travel horizontally as far as possible over the brick radiating surface before passing into the flue. The back is therefore made to slope outwards as much as possible, the slope starting at about the top of the fire and the throat placed well forward. In plan, the sides of the fireplace should have considerable splay so that they also will radiate heat into the room. A damper will help to regulate the draft. In European countries, where heating is accomplished almost entirely by open fireplaces, there are patented systems whereby heated air is supplied at points below the fire, thus helping to secure more complete combustion and greater efficiency.

*For designs of brick mantels write the American Face Brick Association, 130 N. Wells St., Chicago, Ill.

Area of Openings:

6. The Manual of Face Brick Construction recommends the following proportions for fireplace openings:

Table 17. Size of Fireplace Openings

Width	Height	Depth
2′8″	2′4″	17″ to 21″
3′0″	2′4″ to 2′6″	21″
4′0″	2′8″	21″ to 25″

Hearth:

7. The front and back hearth is generally laid of the same brick as the mantel, either flat or on edge. Sometimes the back hearth is of firebrick. The portion projecting into the room rests upon a "trimmer arch", as shown in Plate 9, thrown from the fireplace to the header joist, the filling between the trimmer and the hearth being either lean concrete or mortar.

8. An ash dump, emptying into an ash pit with a cleanout door at the bottom, is a great convenience.

Sides and Back:

9. These also may be formed of the same brick as used for the mantel. Firebrick is sometimes used. The back should be perpendicular for two or three courses, sloping or curving outwards from this point.

Damper and Lintel:

10. There are several good types of damper on the market which also form a lintel to carry the brickwork across the opening. Their use is strongly recommended. Where not used, a separate damper should be placed and the brickwork carried on a steel lintel, except where an arched opening is preferred.

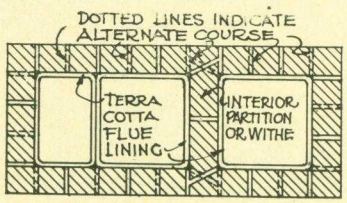
Smoke Shelf:

11. Placing the throat well forward has another advantage—that of forming a smoke shelf at the damper level. This shelf aids in stopping the down drafts which will almost invariably occur if the back of the fireplace is made to rise vertically in the same plane as the back of the flue.

12. The opening above the smoke shelf should be "gathered" or contracted to the size of the flue by corbelling, this being done within the least height practicable. Up to the level of the clay flue lining the brickwork should not be less than 8″ thick, for the space immediately above the damper is the hottest part of the chimney. The flue is generally centered over the fireplace but there is no disadvantage in placing it on either side.

Construction of Fireplace:

13. To prevent the finished mantel being spotted with plaster, the rough work only is installed first, the mantel and hearth being built after the plasterer has finished his work.



PLAN SHOWING BONDING IN CHIMNEY

Figure 48.

Separate Flues:

14. Every fireplace should have a separate flue carried to the top of the chimney, with no other connections. Smoke may easily be carried by down drafts through connections and openings which are not in use.

15. Not more than two flues should be in the same chimney space. Where there are more than two flues, each third flue should be separated by a "withe" or 4″ brick partition. (Fig. 48.)

Thickness of Flue Walls:

16. The least expensive way to build these is to make the walls 4″ thick, lined with burned clay flue lining. With walls of this thickness never omit the lining or replace it with plaster. The expansion and contraction of the chimney would cause the plaster to crack and an opening from the interior of the flue through which flame could pass might eventually be formed. See that all joints are completely filled with mortar.

17. If flue lining is not used, the walls should be not less than 8″ thick, with joints in the flue carefully pointed. In Europe, a mixture of cow dung and lime plaster is used for plastering flues, and is found to crack but little. The plaster is applied as the flue goes up. A bag of shavings fitting the flue tightly may be drawn up by a rope attached to the top of the bag as the flue is built to catch the plaster droppings. The latter is not only useful but very important also in a flue in which clay lining is used, and in which there is an offset, and may save much trouble and cost to contractors in cleaning out flues after completion.

Setting Flue Linings:

18. The flue lining should extend the entire height of the chimney, projecting about 4 in. above the cap and a slope formed of cement to within 2″ of the top of the lining. This helps to give an upward direction to the wind currents about the top of the flue and tends to prevent rain and snow from being blown in.

19. The flue space should not extend up from the foundation but only about a foot below the first connection. The furnace flue should have a cleanout door. Be careful that there is no connection between the flues at the bottom or trouble may be experienced with the draft.

20. Fill all the joints of the flue lining and the space between the lining and the brickwork tightly with mortar.

Chimney Pots:

21. To improve the draft of chimneys already built or to provide an artistic finish for new chimneys, there is a variety of chimney pots of various designs available. The most durable and sightly chimney pots are those of burned clay.

Size of Flue Linings:

22. The following is a table of sizes of clay flue linings. The recommendations of heating apparatus manufacturers should be followed regarding flue sizes and heights. For fireplaces the flue should not be less in net area than one tenth the area of the fireplace opening.

23. The most efficient shape of flue is a round flue, next to that a square flue. Currents in a chimney rise with a circular swirling motion.

Table 18. Size of Rectangular Flue Linings

Outside dimensions	Net inside area
8½ in. x 8½ in.	52 sq. in.
8½ " x 13 "	80 " "
13 " x 13 "	126 " "
13 " x 18 "	169 " "
18 " x 18 "	240 " "

Supports for Chimneys:

24. A wall to support the fireplace and adjacent flues should be built up from a footing in the basement. This wall may be hollow to form an ashpit. Small isolated chimneys may be supported on corbels built out from the wall, although it is better practice in every case to carry the support right down to a bearing below the basement floor.

Chimneys, General:

25. Keep all woodwork—joists, furring strips, rafters, etc., at least 2 inches away from all flues and brick chimney breasts. Above all, never rest any woodwork on the walls of a flue. The partitions between flues (called withes) should be bonded as shown in Fig. 48, page 60.

26. Run each flue vertically from top to bottom if possible to secure the best draft and make it easier to clean. If offsets are necessary, make them gradually or wind currents may occur in the chimney, causing it to smoke. Soot may also lodge in bends that are laid too flat. It is also difficult to cut clay flue lining to make a perfect joint at an angle. Make the slope no flatter than 30 degrees from the vertical.

27. The chimney should be run up at least 1 ft. above the level of the highest ridge to prevent downdrafts. 2 ft. is better. Chimneys constructed entirely within the house are more efficient than chimneys on the outside wall, the former allowing the flues to become hotter, giving a better draft.

28. According to the National Board of Fire Underwriters Chimney Ordinance, mortar for chimneys should be composed of 2 bags Portland cement and 1 bag hydrated lime mixed together thoroughly while dry, added to three times its volume of clean sharp sand. 1 cubic foot of lump lime putty may be substituted for the hydrated lime.

Labor on Chimneys, Flues and Rough Fireplaces:

29. A bricklayer should lay 1000 brick in lime or cement mortar in rough fireplaces and flues in 14 hours. This also includes setting clay flue lining. Helpers time same as bricklayers, if one bricklayer is working. If two or more are working, helpers time 7 hours per 1000 brick.

Labor Building Ash Pit:

30. An ash pit in the basement costs about the same as building a flue.

Labor Building Brick Mantels:

31. One bricklayer should build an ordinary brick mantel including the lining for a fireplace of usual size in 12 hours. Laborers time same as bricklayers if one bricklayer is working. If two are working, laborers time 6 hours. This labor is for the finished brick mantel and lining not including the hearth.

32. On a more elaborate fireplace in Common, Flemish, or English bond with panels or pilasters, a bricklayer should lay about 400 brick per 8 hour day. Helpers time the same as bricklayers if only one bricklayer is working. If two are working, ½ hour laborers time to one hour of bricklayer time.

Laying Brick Hearth in Square or Herringbone Pattern:

33. A bricklayer should set both the front and back hearth of an ordinary fireplace in half an 8 hour day.

Number of Bricks in Fireplaces:

34. To figure the number of bricks in a fireplace, multiply the width of the fireplace by the height from floor to floor and figure it as a solid wall.

35. Then deduct an area equal to the brick displaced by the flues and fireplace from the total area given above. Find material quantities in tables.

Chimney Ordinance:

36. An excellent ordinance covering in detail the construction of chimneys may be had free upon application to the National Board of Fire Underwriters, 76 William Street, New York City.

EQUIPMENT FOR BRICK CONSTRUCTION

(See also "Equipment for Mortar Making," Page 41.)

General:

1. The following deals mostly with equipment required for an ordinary house job.

2. Scaffolding can be used many times over on a number of jobs and its first cost should be charged to equipment.

Shed:

3. A small storage shed should be built on the job to keep cement and lime dry. On a small job, one corner of this shed near the door can be fitted with a window and a rough desk to serve as an office. Toward the completion of the job the shed may be taken down and the boards used for cellar shelving. The cost of the shed should be added to the cost of the job.

Make Scaffolding Safe:

4. Great care should be used to make scaffolding safe. Scaffold accidents are by no means uncommon and are due in most cases to carelessness. "Blind traps," or boards that tip up when walked upon, should be avoided by not allowing the ends of the boards to project more than six inches over their support.

Scaffolding, Where Required:

5. In building the lower part of the basement wall the mason stands in the excavation, the upper part being built from the grade. Scaffold plank on trestles is required in the basement only for independent chimneys and piers.

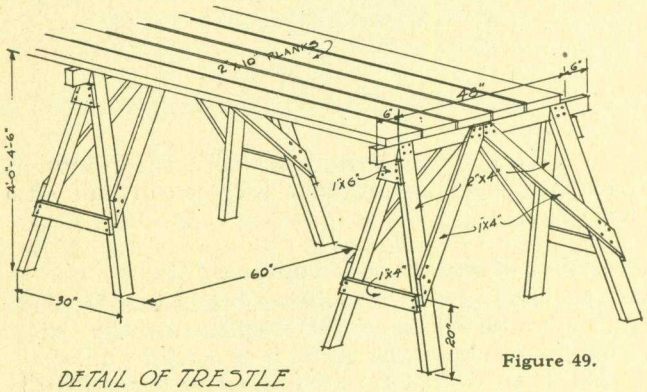
6. Walls above the first floor line are built from inside the house. In all but the cheapest construction a rough underfloor is used and this floor is laid immediately the joists are placed. The mason builds the lower 4 to 4½ feet of each story from the subfloor, scaffold plank on trestles being placed when the wall reaches this height. Where the finished floor is only of one thickness, rough plank flooring must be laid temporarily on the joists, this plank being moved up to the next story when the lower story wall is finished.

7. Walls can be cleaned down from a ladder, or a painter's scaffold may be employed. On higher buildings scaffold brackets may be used to support plank for this purpose if brickwork is cleaned down before plasterer starts, otherwise exterior scaffolding must be used.

8. The carpenter will need an exterior scaffold of some kind to work on the overhanging eaves or cornice.

Trestles and Scaffold Plank:

9. Fig. 49 shows the usual trestle and plank arrangement.



DETAIL OF TRESTLE

Figure 49.

10. Trestles may either be built as shown in Fig. 49 or hinged at the top to fold flat. In the latter case iron hooks and eyes may be used to spread the bottom of the trestle the proper distance apart. Some contractors prefer to bore holes through the bracing or legs, keeping the latter from spreading by passing a rope through the holes, knotted outside. The hinged variety of trestle may be loaded more easily on a wagon.

11. Always keep the trestles 3 inches away from the inside face of the wall so the swing of the scaffold will not push the newly laid wall out of line.

12. Plank for scaffolding should not be less than 2"x10". Sometimes the floor joists intended for a floor above having a plastered ceiling are laid on the trestles and used for scaffold planks. If the basement is not to have a plastered ceiling, this use would get first floor joists too dirty. When the wall is built to the height of the bottom of the joists the scaffold planks are swung up to form the joists. If hemlock joists are used this practice should not be followed. Some states have laws prohibiting the use of hemlock for scaffolding.

Scaffold Brackets:

13. Scaffold brackets for cornice work, the same as those used for frame house construction, are used by Andrew Pentland, Cleveland home builder (Fig. 50). To place upon a newly laid 8" wall the severe side pull of one of these brackets would tend to throw the wall out of line. This is avoided by placing an upright 2"x4" against the inside of the wall behind each bracket, extending over the plate. A 1" piece is placed against the plate to take care of any irregularity of the wall or bend of the 2"x4". The plate is, of course, held in place laterally by the ceiling joists being spiked to it. When the ceiling joists run parallel to the wall, the plate or the upright 2"x4" may be braced with a diagonal 2"x4" extending at the bottom some distance from the wall and nailed to anything convenient, such as a floor joist.

14. The height at which the scaffold will be required is determined before the wall is built and suitable bolts are built into it, greased or wrapped in building paper, being knocked out when the scaffold is taken down.

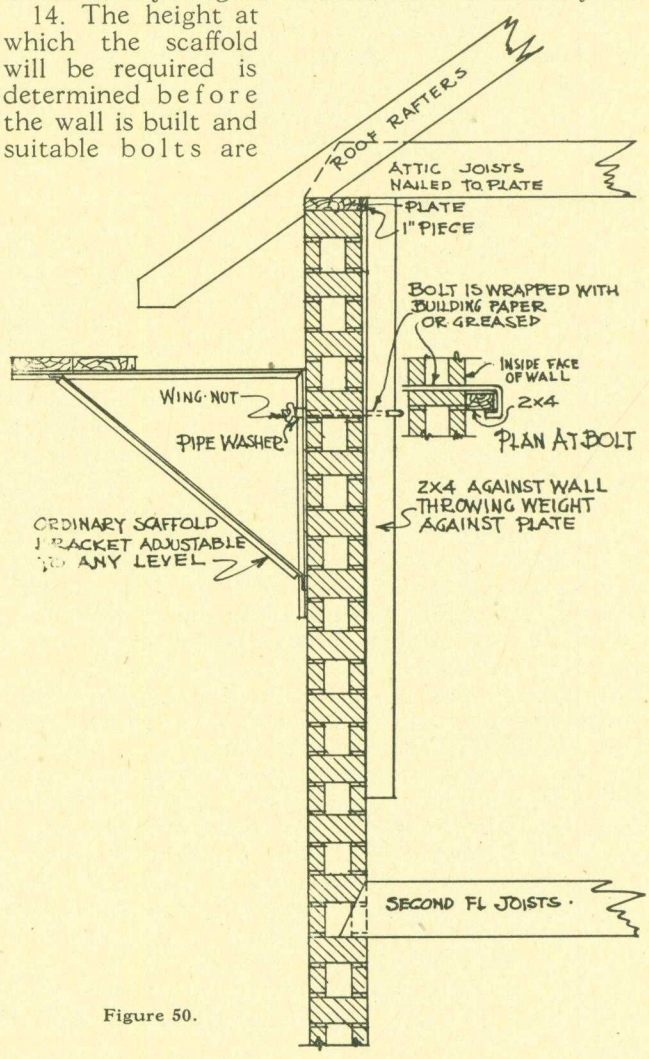


Figure 50.

15. Mr. Pentland states that the use of these brackets saves a very worth while amount of money on each house over the more general method of using built up scaffolding and saves also the cartage of the material used for this scaffolding to another job.

Material Runs:

16. Brick and mortar are generally handled in wheelbarrows for walls up to the height of the second story joists, and a sloping 2"x10" plank wheelbarrow run should be laid from grade through a convenient door opening to the first floor line.

17. Above the line of the second floor joists materials are most conveniently handled in hods. An inexperienced man will at first have difficulty in

carrying a full hod up a ladder and some contractors prefer to use cleated runs of 2″x10″ instead. An experienced man much prefers a ladder.

Mortar Boards:

18. At about five to six foot intervals along the wall to be built, mortar boards, as shown in Fig. 51, should be placed. This should be done regardless of the number of masons building the wall. Much time will be lost if mortar boards have to be constantly moved. If there are three or four mortar boards per man, however, these boards should not be kept so full of mortar as when there is a man to every board, or the mortar will get stiff.

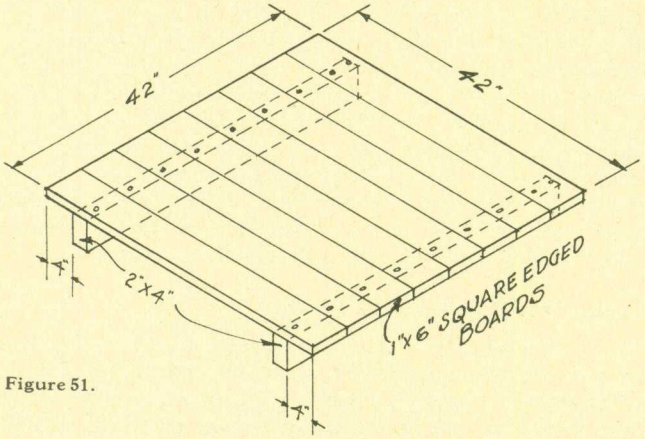


Figure 51.

DETAIL OF MORTAR BOARD

19. The boards should be made of square edged material. If matched stuff is used, it may splinter when a trowel is thrown point downwards to stick into the board.

20. For a very fine face brick job with buttered joints, mortar boards about ⅓ the size of the ordinary mortar board, standing on legs 2′ 6″ high, are used.

Straightedges:

21. The contractor should provide two or three straightedges for each job shown in Fig. 52.

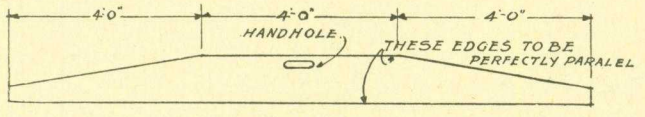


Figure 52. DETAIL OF STRAIGHT EDGE
MATERIAL – 1⅛"X 6" WHITE PINE

Wheelbarrows and Hods:

22. For a small house, on which one or two masons are employed, one wheelbarrow is sufficient.

23. One brick hod and one mortar hod should also be provided for a small job. The average brick hod is 21 by 7 by 7 in. and holds 18 bricks. The average mortar hod is 24 by 12 by 12 in. and 12 in. across the top.

Line:

24. In some localities it is customary for the contractor to provide the bricklayers with line; in others the masons furnish their own. The line in the average mason's kit bag, however, leaves much to be desired and regardless of custom it will generally pay the contractor to furnish the line. Line rotted by lime or cement breaks easily and soon gets full of knots, the loose ends getting into the joints and cutting down the efficiency of the bricklayer. Moreover, when the line breaks, the bricklayers must stop until it can be tied and reset. Line costs only a few cents and it is real economy for the contractor to furnish it.

Large Scaffolds:

25. In constructing larger scaffolds it is important that they be thoroughly braced laterally and either well tied to the wall or braced against adjoining buildings. Fig. 53 shows the use of spring stays, in which two boards are placed in the face of the wall and a wedge driven tightly between them. The boards must be well spiked at the other end.

26. Watch the uprights and at the first sign of buckling or bending add another brace.

27. In placing stringers, running strips or ledge boards, nail them securely at every point of contact and nail each joint completely before passing to the next. It sometimes happens that a ledge board is tacked in place temporarily at one end and left while the other end is being nailed, the fact that the nailing at one end was temporary being forgotten. The supporting members should rest on a solid foundation or a wood cross piece of the required length nailed beneath them.

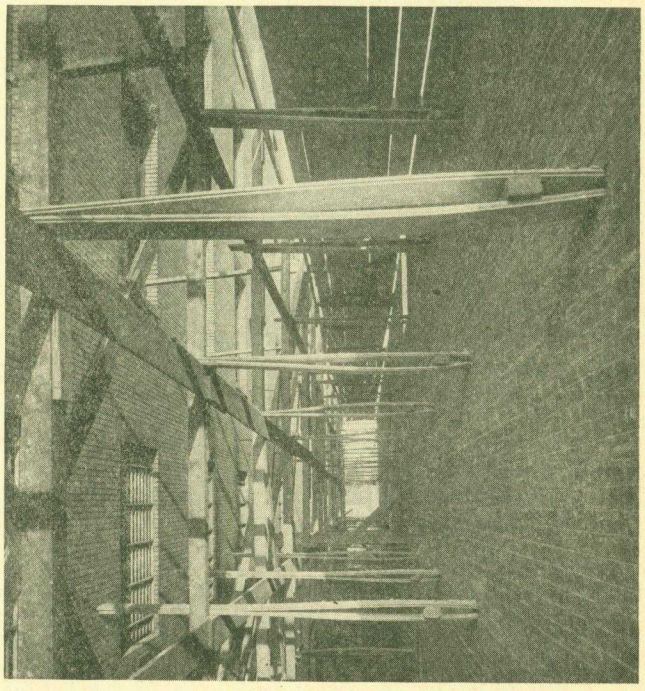


Figure 53. Spring Stays, holding scaffold securely to wall.
(*Courtesy Travelers Insurance Co.*)

BRICK CONSTRUCTION IN FREEZING WEATHER

Cold Weather no Obstacle to Good Work:

1. Good brickwork can be produced in freezing weather and operations successfully carried on during winter weather. Considerable difficulty has been found in demolishing old brick walls constructed in Winnipeg, Canada, through the coldest portion of intensely cold winters. It is the custom today at all important summer resorts to do all construction work throughout the winter. Countless buildings, large and small attest this fact.

Mortar:

2. Portland cement mortar only should be used in freezing weather. Freezing temperatures injure natural cements and lime mortar sets too slowly.

3. It is better not to mix lime with the cement mortar, but in the event that it is used, only just enough lime to barely make the mortar workable should be added, for lime delays cement mortar taking initial set.

Brick:

4. Impervious bricks are laid with more difficulty in freezing weather than are non-impervious brick.

5. Do not wet brick laid in freezing weather. Bricks should be thoroughly dry. No ice should be on them when laid in the wall. Much money will be saved in bricklayers' time if the brick pilesare kept covered with tarpaulins.

Heating Materials:

6. On a small job in a moderate climate it may be possible to avoid the expense of special equipment. Manure may be spread on the soil around footings to prevent penetration of frost beneath them. Sand may be piled in a long high heap. The top and sides of the heap will freeze and sand for use can be tunnelled from the ends. The openings at the ends should be kept closed. Frozen sand must not, of course, be used for making mortar. Mortar should have attained its initial set before it freezes, although some contractors who have successfully carried on operations in freezing weather are satisfied if the mortar can be kept from freezing until placed in the wall. A salamander or fire kept going near the box will help in preventing the mortar from freezing.

7. In severely cold weather, however, and on larger work the following methods may be followed and equipment used.

8. All materials, including brick, water, cement and sand should be heated so that the mortar will be about 60 degrees when bricks are laid. Sand may be heated most conveniently by running horizontally through the material pile a corrugated sheet metal culvert about 20" in diameter and 10 ft. long or an old steel chimney stack or any other circular iron section, keeping a fire going at one end. Water may be heated in a coil attached to the water main with a fire in the centre or in an iron can placed over a fire. Water should not be allowed to get much hotter than 165 degrees or it will injure the mortar. If the water boils, cool it with cold water.

Lowering Freezing Point of Mortar:

9. Salt or calcium chloride may be added to the mortar to lower its freezing point. Both these substances have the great disadvantage, however, that they may cause efflorescence on the face of the wall. A small amount of salt, not exceeding 5 per cent by weight of the water, may be added to the water with which the mortar is mixed. Calcium chloride lowers the freezing point much further than salt, and accelerates the hardening of the mortar. A 4 per cent solution will usually be sufficient and will not affect the strength of the mortar.

Screens for Bricklayers:

10. As stated in Par. 6, it is often possible, where the cold is not too intense, to run a small job in winter without special equipment or protection, and this applies also to protection for bricklayers, although bricklayers are, of course, more comfortable in an enclosed space heated with salamanders.

11. A screen may be constructed of canvas or tarpaulins on light wooden supports, forming an enclosure over the wall being built, with openings for material, etc. Salamanders fired with coke will keep the enclosure comfortable and help the mortar to set. Do not use coal—its gas affects the workers.

Keep Walls Even:

12. If a wall is carried up several feet in a day on one side of the house only, there may be some danger of throwing it out of plumb if the warm rays of the sun strike it. It is better practice to build a less height per day and keep the walls at an even height all around the house. Clipped bond and metal wall ties should be avoided in freezing weather, and headers should be placed at least every 6th course.

Close Up Each Story:

13. Each story should be closed up as soon as the floor joists are laid. Rough flooring above should be placed and openings boarded up, using building paper to cover the cracks. Salamanders should be used to raise the temperature and dry out the wall for the plasterer.

Keep Going in Winter Weather:

14. It is not necessary to shut down in winter. Many operations, small and large, have been successfully put through in cold weather. There's no profit when the work is closed down. By following the suggestions outlined above, the contractor's organization can be kept together and provided with work and the contractor's balance sheet will look better at the end of the year.

BRICK FOR GARDEN USE

Permanent and Most Economical:

1. Brick possesses the same qualities of durability and beauty for outside uses as for the walls of the home. Brick harmonizes well with any garden, formal or otherwise. Creepers and vines cling well to it and do not cause it to decay. Its beautiful colors and soft texture, forming a background for foliage and flowers, look cool and inviting even on the hottest summer day. It does not "glare" in the sun, and it links house and garden into one harmonious design.

2. Summer houses, garden walls, seats, steps, pergolas, gate posts and walks, form but a few of the instances where advantage may be taken of the unrivalled beauty, permanence and ultimate economy of brickwork.

Brick Walks:

3. Brick for this purpose should be hard burned. Ask the manufacturer whether his bricks are suitable for this use. Walks may be laid in one of two ways, either on sand or cinders or on a concrete base, in the latter case with mortar or sand joints.

4. For those who prefer a walk to be a little irregular, perhaps with grass growing up in the joints, the first mentioned method is recommended. Grass can easily be kept down if desired, however, by salt being mixed with the sand. The bricks can be laid either flat or on edge.

5. A method of laying walks by this method is illustrated in Figs. 54-55. First excavate the soil to the depth of about 4 inches. Lay 1 inch thickness of sand for the border brick, which are placed on edge. Then lay and tamp or roll a 2 inch bed of sand or cinders for the rest of the walk, placing the bricks flat. It is important, especially in a clay soil, to thoroughly drain the sand or cinder bed. If bricks are on edge the excavation should be proportionately deeper. Leave about ½ inch space between the bricks. As soon as they are laid, fill the vertical joints by placing a layer of sand on the walk and sweep it into the joints with a broom. Leave the sand on the walk for a few days, agitating it once or twice a day, so that the joints will be completely filled. Tight mortar joints may be used, however, as described in pars. 7-9.

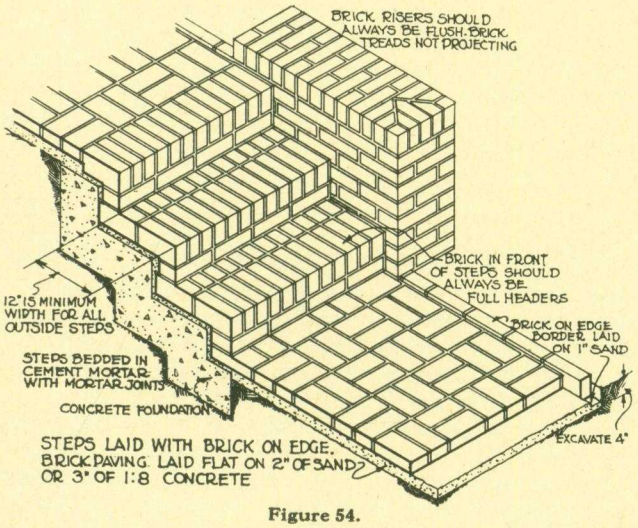

BRICK RISERS SHOULD ALWAYS BE FLUSH. BRICK TREADS NOT PROJECTING
BRICK IN FRONT OF STEPS SHOULD ALWAYS BE FULL HEADERS
BRICK ON EDGE BORDER LAID ON 1" SAND
12" IS MINIMUM WIDTH FOR ALL OUTSIDE STEPS
STEPS BEDDED IN CEMENT MORTAR WITH MORTAR JOINTS
CONCRETE FOUNDATION
EXCAVATE 4"
STEPS LAID WITH BRICK ON EDGE. BRICK PAVING LAID FLAT ON 2" OF SAND OR 3" OF 1:8 CONCRETE

Figure 54.

6. A concrete base will ensure the walk remaining rigid and even. (Plate 8.) A lean 1:8 concrete should be used, 3" thick, laid on a bed of cinders or sand, thoroughly drained. The brick may be laid on a ½" setting bed of cement mortar or upon a bed of sand just thick enough to straighten out the irregularities of the rough concrete. The curb may be formed of concrete or of brick on edge. The vertical joints may be sanded, or filled with mortar.

7. In the latter case the most satisfactory but most expensive method is to trowel the joints (par. 16). A cheaper way is to broom the joints full of a thin 1:3 cement grout, but this has the disadvantage of smearing the surface of the brick with mortar, which may, however, be removed by going over the surface while the mortar is soft with a scrubbing brush and water containing not more than 5% of muriatic acid, afterwards removing the acid by scrubbing again with clean water.

8. Another and better method is to carefully pour the grout into the joints, wiping the brick clean before mortar has set.

9. If bricks are laid with tight mortar joints, the walk should be slightly crowned for drainage if on flat ground. If laid with sand joints on concrete, the latter should have a slight crown.

Labor laying Brick Walks:

10. A laborer should spread, smooth and tamp 125 square feet of sand in one hour. A bricklayer should lay 2500 brick for paving laid flat per 8 hour day as shown in Fig. 55.

11. Laborer's time for handling brick will be double bricklayers' time, and add 2 hours per thousand sweeping joints full of sand.

12. A laborer can grout 70 to 80 square feet of brick paving per hour, sweeping it in with a broom.

Number of Bricks in Walks:

13. If the walks are to be laid with brick on edge, figure the number of bricks by finding the area and reading the number of bricks required for a 4 inch wall, table 28, page 71.

14. If the bricks are laid flat, about 4 brick per

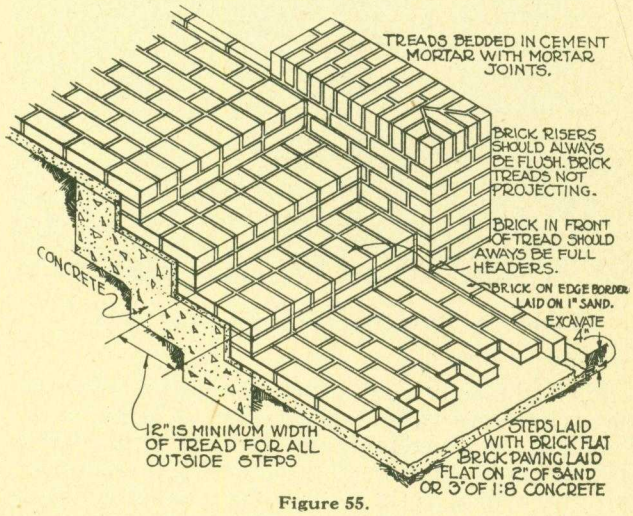

TREADS BEDDED IN CEMENT MORTAR WITH MORTAR JOINTS.
BRICK RISERS SHOULD ALWAYS BE FLUSH. BRICK TREADS NOT PROJECTING.
BRICK IN FRONT OF TREAD SHOULD AWAYS BE FULL HEADERS.
BRICK ON EDGE BORDER LAID ON 1" SAND.
CONCRETE
EXCAVATE 4"
12" IS MINIMUM WIDTH OF TREAD FOR ALL OUTSIDE STEPS
STEPS LAID WITH BRICK FLAT
BRICK PAVING LAID FLAT ON 2" OF SAND OR 3" OF 1:8 CONCRETE

Figure 55.

sq. ft. will be required. For a walk 3 bricks wide, allow ½ cu. ft. sand, 2" thick per ft. run of walk; 4 bricks wide, ⅝ cu. ft., 5 bricks wide, ¾ cu ft.

Outside Steps:

15. These should always be laid on concrete. Treads should never be less than 12" wide, or they may be dangerous when covered with ice and snow. Steps should pitch forward with a slope of about ¼" per foot. The under surface of the concrete base should never slope, but be stepped off horizontally or the concrete will very likely slide out of place. The concrete should be thick enough to prevent it breaking. It may be reinforced if necessary. Figs. 54-55. Page 65.

16. Joints in steps should always be filled with rich cement mortar, and pointed with a "thumb" joint, which is a broad slightly concave joint thoroughly rubbed with a steel jointing tool. The front of the treads should be laid of full length headers. Half bricks should not be used in this position. It is good practice to give the face of the brick to be

exposed a coat of raw linseed immediately before laying, as this prevents mortar sticking to the face of the brick and produces a clean job.

Garden Walls:

17. A brick wall is unexcelled either as a division wall or to shelter plants in certain exposures.

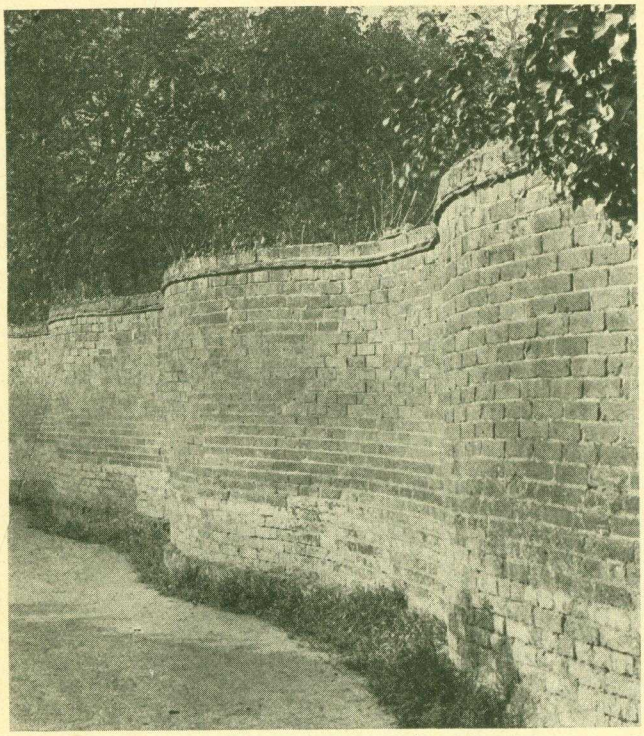


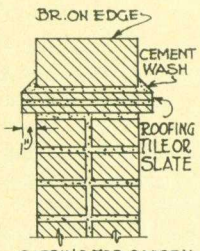
Figure 56. Beautiful curved garden wall, 4" thick.

18. Eight inch Ideal all-rolok walls or solid walls make charming walls for the garden. A straight wall should be thickened to form 12"x12" or 12"x16" piers at intervals of about 10-12 ft. according to the height, to add stability to the wall. Offsets or irregularities in the plan answer the same purpose. The wall should extend below the frost line, but no footing is required. Portland cement mortar should be used.

19. In the case of a wall dividing the same property into two or more parts, a wall 4" in thickness may be built as shown in Fig. 56, the curves in the plan of the wall giving it the necessary stability. The wall shown, 4 inches thick and about 8 feet high, has been standing over a century. It produces a variety of shady and sunny surfaces.

Capping Garden Walls:

20. The wall should be capped with a course of brick on edge in rich 1:2 Portland cement mortar. An artistic touch may be provided by placing two courses of slate or tile below the capping projecting about 1" on each side of the wall. (Fig. 57.)



CAPPING FOR GARDEN WALLS

Figure 57

Pergola Posts; Gate Posts:

21. Hollow piers or posts, either of brick on edge or flat make sightly and permanent supports for the pergola roof. The brick on edge posts should not be more than 11"x11", the flat brick posts 12"x12". The interior may be left hollow. Footings should extend below frost line.

22. Gate posts and entrance posts may be built in the same manner, the gate being secured by bolts with anchor ends extending far enough into the post to take the strain, or passing entirely through the post with a plain or ornamental washer on the opposite side. Brickwork should be made solid and the pier large enough to stand the lateral strain of the gate. A charming effect may be secured by building a brick semi-circular arch over the gateway. There should be sufficient brickwork at the haunches to resist the thrust of the arch. Wrought iron gates, lamps, strapwork and other ornamental features are very effective when used in combination with brick.

BRICK IS BEST FOUNDATION FOR STUCCO

Stucco:

1. Stucco is plaster in various surface textures applied to exterior walls. In its natural state, however, cement finish is dreary and lifeless compared to the rich sparkling effects produced by exposing the brick.

2. A house finished in stucco placed upon a base of any construction cannot compete in price with the Ideal wall, with its beautiful everlasting brick surface; and in many localities the solid wall furred compares very favorably in price with the stucco house. It should be noted, however, that the price of the latter varies considerably according to the nature of the construction behind the stucco; and the fire-resistiveness and permanence of the underlying construction should always be carefully considered.

3. Inasmuch as the Ideal wall is the lowest in cost of any wall that can be constructed, it is suggested, if stucco finish appears desirable, to obtain bids upon this finish placed upon the Ideal all-rolok wall built with the lowest cost brick. Providing that all the headers, and the stretchers in the outer web, are fairly hard burned, even "cull" brick are entirely suitable for this purpose.

4. Stucco is a somewhat unreliable finish, however, inasmuch as its durability depends on the degree of its adhesion to its base, and there are many instances where stucco has disappointed owners by its tendency to peel away.

5. If a stucco finish is specially desired, a brick surface with joints left rough is far superior to any other building material yet devised as a base upon which to place it. The surface of the brick itself is of a nature that enables the stucco to bond into it, if well wet when the latter is applied, and if the joints are left rough a mechanical "key" is also provided, and brickwork, of course, never shrinks.

TABLES OF MATERIAL AND LABOR QUANTITIES FOR BRICKWORK

Example of Using Tables:

1. The following tables are designed to almost eliminate the calculations required to determine the amount of brick, mortar, laborers time, and bricklayers time for an ordinary building.

2. To illustrate their use, figure the number of brick, materials required for mortar, laborers and bricklayers time required for 240 square feet of Ideal all-rolok wall 8" thick. Referring to Table 23, page 69, the number of brick required for 200 feet is 1807, and for 40 feet, 361, added together these equal 2168 brick. Of these, 1205 plus 241 equal 1446 would be exposed. Laborers time for 200 square feet is 12 hours, and for 40 square feet is 2.5 hours, total 14.5 hours. Bricklayers time for 200 square feet is 16 hours, and for 40 square feet 3 hours, total 19 hours. Cubic feet of mortar totals 19 feet. Turning to Table 29, we find 19 cubic feet of cement-lime mortar requires 2.5 bags cement, 2.8 sacks hydrated lime, and 0.7 cubic yards of sand.

3. Add to the above any special items necessary, such as cost of foreman, if one is employed; rental of hoisting machinery and engineers time and fuel if job is large and such machinery used; special scaffolding, if such is necessary; cleaning down; mortar color; overhead expense and profit. (Par. 16.)

Estimates Based on Work of Experienced Men:

4. The time required to perform work is based on the average performance of experienced bricklayers and laborers. In some districts where bricklaying is done by men who are not so familiar with the work, the time allowance should be correspondingly increased.

Laborers Time:

5. Laborers time includes time for making and handling mortar, handling brick from pile on the ground, waiting on bricklayer, moving scaffold, etc. Laborers time for cleaning brickwork is not included in these tables and should be added if the brick wall surfaces are to be cleaned. (See par. 112, page 59.)

Bricklayers Time:

6. The figures in the tables which follow show the average number of brick laid on a small job in a country town. These figures can easily be increased through forethought and good management, so that each man may work with a clear cut job before him without making any waste motions.

7. On large work and in cities, bricklayers will lay 1500 brick per day on a solid wall, including facing and backing. Mr. Thos. R. Preece, first vice-president of the Bricklayers, Masons, and Plasterers International Union, stated to the author that a bricklayer in Chicago who does not lay that amount every day could not hope to hold his job. The number of brick per day is figured in the tables far below the number quoted by Mr. Preece for solid work, and far under the number which experience has proved possible for Ideal walls (par. 30, page 12). Under good management there is no reason why these figures should not be equalled in any part of the country. The production of bricklayers now equals pre-war figures. Measure the work occasionally, and keep a record on every job you build.

8. Bricklayers time is calculated on the basis of work ordinarily required for the construction of an ordinary building under ordinary conditions. In case work has many special features, such as pilasters etc., or where special patterns must be formed on the surface of the wall or for cornice work, the bricklayers time should be increased according to the character of the work to be done. See also pars. 29-33, page 61, for time required to build chimneys and fireplaces.

Deducting Openings:

9. In figuring the area of a wall, deduct all openings, no matter how small. In making an allowance for the area of an opening, take the exact area of the masonry opening. This will give a little leeway in the case of double hung windows, for the recess occupied by the box is not deducted.

Simplicity of Figuring Brick:

10. There is only one way to safely estimate the cost of any kind of structure. That way is to figure each item carefully.

11. A brick house cannot be accurately figured by first estimating what the same house would cost in frame and then quoting almost offhand a higher price for brick. "Guess" systems do not make contractors prosperous in these days of competition and high efficiency. The contractor employing them is not prepared to meet competition because he never knows his exact costs. It is no harder to estimate a brick than a frame house. Every step in the process is very simple.

12. The data presented in the tables is absolutely reliable, and makes it possible for a contractor to arrive at the actual cost of the brick portion of a building at prices of material and labor which obtain at the moment in his own part of the country. The tables give the amount of material and labor necessary to perform the work. The actual cost can then be easily determined by local prices and wages.

Keep Records:

13. We suggest that the contractor keep his itemized estimates in a book, and follow them up by keeping careful records of the actual time and material consumed on each portion of every job. This will make future estimating much easier.

As Between Brick and Frame, Only Walls Above Foundation Vary in Cost:

14. The cost of the foundation and inside of the house—the joists, flooring, trim, wood partitions, chimneys, wiring, heating, roofing and interior finish—all these items show no variation, whether the house is of brick or frame.

15. The walls built of brick above the first floor line only will vary in cost and at present prices of

brick, with the increasing necessity for conserving lumber there can be little question as to the economy and desirability of brick.

Don't Forget Contractor's "Overhead":

16. The contractor is reminded that the actual cost of the building consists not only of the cost of materials and labor, but must include a reasonable sum for overhead expense. Fire and accident or liability insurance, bond, general supervision, and office expense are some such items. The cost of materials and labor plus the "overhead" represents, therefore, the cost of the building to the contractor. The contractor's percentage of profit should be based upon and added to the total cost of materials, labor and overhead.

Number of Face Brick in Solid Walls:

17. The following data is issued by the American Face Brick association.

Table 19. Number of Face Brick per Square Foot of Wall:

Joint	1/8"	1/4"	3/8"	1/2"	5/8"	3/4"
No. of brick	7 1/2"	7 "	6 1/2"	6 1/8"	5 3/4"	5 1/2"

18. The foregoing number of brick will be sufficient only for straight running bond, with no headers. It is apparent that an additional number of brick will be required for various bonds in proportion to the number of through headers used. The following percentages are therefore added to the number of face brick arrived at by the foregoing table.

Table 20. Percentages Added to Table 19 for Various Bonds.

Common (full header course every 5th course) ..... 20 % (1/5)

Common (full header course every 6th course) 16 2/3% (1/6)

Common (full header course every 7th course) 14 1/3% (1/7)

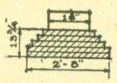
English or English Cross (full headers every 6th course) 16 2/3% (1/6)

Flemish (full headers every 6th course). 5 2/3% (1/18)

Double Header (two headers and a stretcher every 6th course) 8 1/3% (1/12)

Double Header (two headers and a stretcher every 5th course) 10% (1/10)

TABLE 21.—Brick footings ½" joints. Materials and labor for lengths in feet. Laborer's time includes mortar making. Cement mortar should be used. See Table 29 for material needed for cubic feet of mortar.



Length of Footing in Feet	8-INCH WALL					12-INCH WALL					16-INCH WALL					Length of Footing in Feet
	No. of Brick	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx Time, Hours: Lime or Cement-lime Mortar	Bricklayer's Approx Time, Hours: Cement Mortar	No. of Brick	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx Time, Hours: Lime or Cement-lime Mortar	Bricklayer's Approx Time, Hours: Cement Mortar	No. of Brick	Cu. ft. of Mortar	Laborer s Approx. Time Hours	Bricklayer's Approx. Time, Hours: Lime or Cement-lime Mortar	Bricklayer's Approx. Time, Hours: Cement Mortar	
1	22.713	.385	.176	.129	165	28.106	.477	.218	.160	.204	45.945	.780	.366	.230	.285	1
2	46	1	¼	¼	¼	57	1	½	¼	½	92	2	¾	½	¾	2
3	69	1½	½	½	½	85	1½	¾	½	½	138	2½	1	¾	1	3
4	91	2	¾	½	½	113	2	1	¾	¾	184	3½	1½	1	1¼	4
5	114	2	1	¾	¾	141	2½	1	¾	1	230	4	1¾	1¼	1½	5
6	137	2½	1	¾	1	169	3	1¼	1	1¼	276	5	2¼	1½	1¾	6
7	159	3	1¼	1	1¼	197	3½	1½	1¼	1½	322	5½	2½	1¾	2	7
8	182	3½	1½	1	1¼	225	4	1¾	1¼	1¾	368	6½	3	2	2¼	8
9	205	3½	1½	1¼	1½	253	4½	2	1½	1¾	414	7½	3¼	2¼	2½	9
10	228	4	1¾	1¼	1¾	282	5	2¼	1½	2	460	8	3¾	2½	3	10
20	455	8	3½	2½	3¼	563	10	4½	3¼	4	919	16	7¼	4¾	5¾	20
30	682	12	5¼	4	5	844	14½	6½	4¾	6	1378	24	11	7	8½	30
40	909	15	7	5¼	6½	1125	19	9	7	8	1837	31	15	9	11½	40
50	1136	20	9	7	8	1406	24	11	8	10	2296	39	18	12	14¼	50
100	2272	39	18	15	16	2812	48	22	16	20	4592	78	36	24	28½	100

TABLE 22.—Piers laid with ½" joints. All joints filled with mortar. Materials and labor for heights in feet. Laborer's time includes mortar making. See Table 29 for materials needed for cubic feet of mortar

Height in Feet	8 x 12 Solid. Brick Laid Flat				12 x 12 Solid. Brick Laid Flat				12 x 16 Solid. Brick Laid Flat				10¾ x 10¾ Hollow. Brick Laid on Edge				Height in Feet
	No. Brick	Cu. Ft. Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx Time Hours	No Brick	Cu. Ft Mortar	Laborer's Approx Time Hours	Bricklayer's Approx Time Hours	No Brick	Cu. Ft Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx Time Hours	No Brick	Cu. Ft. Morta.	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	
1	12.320	.209	.096	.164	18.481	.313	143	.246	24.641	.433	.192	.328	11.3	.088	.120	.180	1
2	25	½	¼	¼	37	¾	¼	½	50	1	½	¾	23	½	¼	½	2
3	37	¾	¼	½	56	1	½	¾	74	1½	½	1	34	½	½	½	3
4	50	1	½	¾	74	1½	½	1	99	1¾	¾	1¼	46	½	½	¾	4
5	62	1¼	½	¾	93	1¾	¾	1¼	124	2¼	1	1¾	57	½	½	1	5
6	74	1½	½	1	111	2	1	1½	148	2¾	1¼	2	68	½	¾	1	6
7	87	1½	¾	1¼	130	2¼	1	1¾	173	3¼	1½	2¼	80	½	1	1¼	7
8	99	1¾	¾	1¼	148	2¾	1¼	2	198	3½	1½	2¾	91	½	1	1½	8
9	111	2	1	1½	267	3	1¼	2¼	222	4	1¾	3	102	1	1	1¾	9
10	124	2¼	1	1¾	185	3¼	1½	2½	247	4½	2	3¼	113	1	1¼	2	10
20	247	4½	2	3¼	370	6½	3	4½	494	9	4	6½	226	2	2½	3¾	20

TABLE 23—Exterior Ideal All-Rolok Wall. Materials and labor for square foot areas. Laborer's time includes mortar making. Cement-lime mortar should be used. See Table 29 for materials needed for cubic feet of mortar. For table of heights by courses see table 5, page 26.

Sq. Ft. area of wall	8-INCH WALL						12½ INCH WALL								Sq. Ft. Area of Wall
							TYPE SHOWN ON PLATE 1				TYPE SHOWN ON PLATE 2				Types Shown on Plates 1 and 2		
	Total No. of Brick including Facing Brick	No. of Facing Brick	Av. Weight in Pounds	Cu. Ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	Total No. of Brick incl. Facing Brick	No. of Facing Brick	Av. Weight in Pounds	Cu. ft. of Mortar	Total No. of Brick incl. Facing Brick	No. of Facing Brick	Av. Weight in Pounds	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	
1	9.035	6.023	50.365	.080	.061	.076	13.287	5.270	74.022	.118	14.305	6.023	80.229	.132	.090	.111	1
10	90	60	504	1	.5	.75	133	53	740	1	143	60	802	1½	1	1	10
20	181	120	1,007	1½	1	1.5	266	105	1,480	2½	286	120	1,605	2½	2	2	20
30	271	181	1,511	2½	2	2.5	399	158	2,221	3½	429	181	2,407	4	2.5	3.5	30
40	361	241	2,015	3	2.5	3	531	211	2,961	4½	572	241	3,209	5	3.5	4.5	40
50	452	301	2,518	4	3	4	664	264	3,701	6	715	301	4,011	6½	4.5	5.5	50
60	542	361	3,022	5	3.5	4.5	797	316	4,441	7	858	361	4,814	8	5.5	6.5	60
70	632	422	3,526	5½	4.5	5.5	930	369	5,182	8½	1,001	422	5,616	9	6.5	8	70
80	723	482	4,029	6½	5	6	1,063	422	5,922	9½	1,144	482	6,418	10½	7.5	9	80
90	813	542	4,533	7½	5.5	7	1,196	474	6,662	10½	1,288	542	7,221	12	8	10	90
100	904	602	5,036	8	6	8	1,329	527	7,402	12	1,431	602	8,023	13	9	11	100
200	1,807	1,205	10,073	16	12	16	2,657	1,054	14,805	24	2,861	1,204	16,046	26	18	22	200
300	2,711	1,807	15,109	24	19	23	3,986	1,581	22,207	36	4,292	1,807	24,069	40	27	34	300
400	3,614	2,409	20,146	32	25	30	5,315	2,108	29,609	47	5,722	2,409	32,092	53	36	45	400
500	4,518	3,012	25,182	40	31	38	6,644	2,635	37,011	59	7,153	3,012	40,115	66	45	56	500
600	5,421	3,614	30,219	49	37	46	7,972	3,162	44,414	71	8,584	3,614	48,138	79	55	67	600
700	6,325	4,216	35,255	57	43	53	9,301	3,689	51,816	83	10,014	4,216	56,160	92	64	78	700
800	7,228	4,819	40,292	65	49	61	10,630	4,216	59,218	95	11,445	4,819	64,183	107	73	90	800
900	8,132	5,421	45,328	73	56	68	11,958	4,744	66,621	107	12,875	5,421	72.206	119	82	100	900
1,000	9,035	6,024	50,365	81	62	76	13,287	5,271	74,023	119	14,306	6,024	80,229	132	91	112	1,000
2,000	18,071	12,047	100,729	162	124	156	26,574	10,541	148,046	237	28,612	12,047	160,458	264	182	224	2,000
3,000	27,106	18,071	151,094	243	184	228	39,862	15,811	222,069	356	42,918	18,071	240,688	396	273	336	3,000
4,000	36,141	24,094	201,459	324	247	304	53,149	21,082	296,091	474	57,224	24,094	320,917	528	364	448	4,000
5,000	45,176	30,118	251,823	404	309	380	66,436	26,353	370,114	593	71,529	30,118	401,146	661	455	559	5,000
6,000	54,212	36,141	302,188	485	370	457	79,723	31,624	444,137	711	85,835	36,141	481,375	793	545	671	6,000
7,000	63,247	42,165	352,553	566	433	533	93,010	36,894	518,160	830	100,141	42,165	561.604	925	636	783	7,000
8,000	72,282	48,188	402,918	647	495	609	106,298	42,165	592,183	949	114,447	48,188	641,834	1,057	727	895	8,000
9,000	81,318	54,211	453,282	728	556	685	119,585	47,435	666,206	1,067	128.753	54,212	722.063	1,189	818	1,007	9,000
10,000	90,353	60,235	503,647	809	618	761	132,872	52,706	740,228	1,186	143,059	60.235	802.292	1,321	909	1,119	10,000

TABLE 24—Exterior Ideal Rolok-Bak Wall. Material and labor for square foot areas. Laborer's time includes mortar making. Cement-lime mortar should be used. See Table 29 for material needed for cubic feet of mortar. Table 5, page 26, gives heights by courses.

Sq.ft. area of wall	8-INCH WALL									12½-INCH WALL							Sq. ft. area of wall
	Flemish headers every 6th course			Flemish headers every 3rd course			Headers every 3rd and every 6th course										
	Total No. of brick incl. facing brick	No. of facing brick	Average weight in pounds	Total no. of brick	No. of facing brick	Average weight in pounds	Cu. ft. of mortar	Laborer's approx. time Hours	Bricklayer's approx. time Hours	Total no. of brick incl. facing Brick	Facing brick, Flemish headers 6th course	Facing brick, Flemish headers 3rd course	Average weight in pounds	Cu. ft. of mortar	Laborer's approx. time Hours	Bricklayer's approx. time Hours	
1	10 524	6.502	60.854	10.786	6.844	62.454	.116	.065	.080	15.443	6 502	6.844	87.634	151	.095	.117	1
10	105	65	609	108	68	625	1	.5	.75	154	65	68	876	1 5	1	1.25	10
20	210	130	1,217	216	137	1,249	2.5	1.5	1.5	309	130	137	1,753	3	2	2.5	20
30	316	195	1,826	323	205	1,874	3.5	2	2.5	463	195	205	2,629	4 5	3	3.5	30
40	421	260	2,434	431	274	2,498	4.5	2.5	3	618	260	274	3,505	6	4	4.5	40
50	526	325	3,043	539	342	3,123	6	3	4	772	325	342	4,382	7.5	4.5	6	50
60	631	390	3,651	647	411	3,747	7	4	5	927	390	411	5,258	9	5.5	7	60
70	737	455	4,260	755	479	4,372	8	4.5	5.5	1,081	455	479	6,134	10.5	6.5	8	70
80	842	520	4,868	862	548	4,996	9.5	5	6.5	1.235	520	548	7,011	12	7.5	9.5	80
90	947	585	5,468	970	616	5,621	10.5	6	7	1.390	585	616	7,887	13.5	8.5	10.5	90
100	1,052	650	6,085	1,078	684	6,245	12	6.5	8	1,544	650	684	8,763	15.0	10	12	100
200	2,105	1,301	12,171	2,156	1,369	12,491	23	13	16	3,089	1,301	1,369	17,526	30	19	24	200
300	3,157	1,951	18,256	3,234	2,053	18,736	35	20	24	4,633	1,951	2,053	26,290	45	29	35	300
400	4,210	2,601	24,342	4,312	2,738	24,982	46	26	32	6,177	2,601	2,738	35,054	60	38	47	400
500	5,262	3,251	30,427	5,390	3,422	31,227	58	33	40	7,722	3,251	3,422	43,817	76	48	59	500
600	6,314	3,901	36,513	6,468	4,107	37,473	69 5	39	48	9,266	3,901	4,107	52,581	91	57	70	600
700	7,367	4,552	42,598	7,547	4,791	43,718	81	46	56	10,810	4,552	4,791	61,344	106	67	82	700
800	8,419	5,202	48,684	8,625	5,476	49,964	93	52	64	12,355	5,202	5,476	70,108	121	76	94	800
900	9,472	5,852	54,684	9,703	6,160	56,209	104.5	59	72	13,899	5,852	6,160	78,871	136	86	106	900
1,000	10,524	6,503	60,855	10,781	6,845	62,455	116	65	80	15,443	6,503	6,845	87,634	151	96	118	1,000
2,000	21,048	13,005	121,709	21,561	13,690	124.909	232	130	160	30,887	13.005	13,690	175,269	302	191	235	2,000
3,000	31,572	19,508	182,564	32,342	20,535	187,364	349	195	241	46,330	19,508	20,535	262,904	453	287	352	3,000
4,000	42,096	26,011	543,419	43,123	27,380	249 818	465	261	321	61,773	26,011	27,380	350,539	605	382	471	4,000
5,000	52,620	32,513	304,273	53,904	34 225	312,273	581	326	401	77,222	32,513	34,225	438,174	756	478	588	5,000
6,000	63,144	39,016	365,128	64,684	41,070	374,727	697	391	481	92,661	39,016	41,070	525,808	907	574	706	6,000
7,000	73,668	45,519	425,983	75,465	47 914	437,182	813	456	561	108,103	45,519	47,914	613,443	1,058	669	824	7,000
8,000	84,193	52,021	486,837	86,246	54.759	499,636	929	521	641	123,547	52,021	54,759	701,078	1,209	765	941	8,000
9,000	94,717	58,524	546,837	97,027	61,604	562,091	1046	586	721	138,990	58,524	61,604	788,713	1,360	860	1,059	9,000
10,000	105,241	65,027	608,547	107,807	68,449	624,545	1162	651	801	154,433	65,027	68,449	876,347	1,512	956	1,177	10,000

TABLE 25—Solid Exterior basement walls, ½″ joints. Materials and labor for square foot areas.

Exterior 4″ thickness of wall laid with all joints filled. Remaining brick laid on a full bed of mortar, but brick touching end to end. Vertical space between each 4″ thickness filled with mortar. Every 5th course a header course. Laborer's time includes mortar making. Cement-lime mortar should generally be used for exterior basement walls. See Table 29 for materials needed for cubic feet of mortar. For weight of solid walls see Table 1, page 9. For table of heights by courses see Table 5, page 26.

Sq. Ft Area of Wall	8-INCH WALL					12-INCH WALL					16-INCH WALL					Sq. Ft. Area of Wall
	No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time, Hours	Bricklayer's Approx. Time Hours: Lime or Cement-lime Mortar	Bricklayer's Approx. Time Hours: Cement Mortar	No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time, Hours	Bricklayer's Approx. Time Hours: Lime or Cement-lime Mortar	Bricklayer's Approx. Time Hours: Cement Mortar	No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time, Hours	Bricklayer's Approx. Time Hours: Lime or Cement-lime Mortar	Bricklayer's Approx. Time Hours: Cement Mortar	
1	12.706	.195	.097	.073	.092	19.251	.314	.148	.110	.140	25.796	.433	.199	.129	.159	1
10	128	2	1	¾	1	193	3½	1½	1	1½	258	4½	2	1½	2	10
20	255	4	2	1½	2	386	6½	3	2½	3	516	9	4	3	3½	20
30	382	6	3	2¼	3	578	9½	4½	3½	4½	774	13	6	4	5	30
40	509	8	4	3	4	771	13	6	4½	6	1032	18	8	5½	6½	40
50	636	10	5	4	5	963	16	7½	5½	7	1290	22	10	6½	8	50
60	763	12	6	4½	5½	1156	19	9	7	9	1548	26	12	8	9½	60
70	890	14	7	5	6½	1348	22	11	8	10	1806	31	14	9	11½	70
80	1017	16	8	6	7	1541	25	12	9	11	2064	35	16	10½	13	80
90	1144	18	9	6½	8	1733	28	14	10	13	2322	39	18	12	14½	90
100	1271	20	10	7	9	1926	32	15	11	14	2580	44	20	13	16	100
200	2542	39	20	15	19	3851	63	30	22	28	5160	87	40	26	32	200
300	3812	59	29	22	28	5776	94	45	33	42	7740	130	60	39	48	300
400	5083	78	39	29	37	7701	126	60	44	56	10,319	173	80	52	64	400
500	6353	98	49	36	46	9626	157	74	55	70	12,899	217	100	65	80	500
600	7624	117	58	44	56	11,551	189	89	66	84	15,479	260	120	78	95	600
700	8895	137	68	51	65	13,476	220	104	77	98	18,058	303	140	90	111	700
800	10,165	156	78	58	74	15,402	251	120	88	112	20,638	347	160	103	127	800
900	11,436	175	87	66	83	17,327	283	134	99	126	23,218	390	180	116	143	900
1000	12,706	195	97	73	93	19,252	314	149	110	140	25,797	433	200	129	159	1000
2000	25,412	390	194	145	185	38,503	628	297	220	280	51,594	866	400	258	318	2000
3000	38,118	584	291	218	277	57,754	942	445	330	420	77,391	1299	599	387	477	3000
4000	50,824	779	388	291	370	77,006	1255	594	440	560	103,188	1732	799	516	636	4000
5000	63,530	973	485	363	462	96,257	1569	742	550	700	128,984	2165	999	645	795	5000
6000	76,236	1168	582	436	555	115,508	1883	890	660	840	154,781	2599	1199	774	954	6000
7000	88,942	1363	679	508	647	134,760	2197	1039	770	980	180,578	3032	1398	903	1113	7000
8000	101,648	1557	776	581	739	154,011	2511	1186	880	1120	206,375	3465	1598	1032	1272	8000
9000	114,353	1752	873	654	832	173,262	2825	1336	990	1260	232,172	3998	1798	1161	1431	9000
10000	127,059	1947	970	726	924	192,514	3139	1484	1100	1400	257,968	4331	1998	1290	1590	10000

TABLE 26—Solid exterior walls above grade in common bond ½″ joints. Materials and labor for square foot areas. All joints in outside 4″ thickness filled with mortar. Remaining brick laid on full bed of mortar but with brick touching end to end. Vertical space between each 4″ thickness left open. Every 5th course a header course. Laborer's time includes mortar making. See Table 29 for materials needed for cubic feet of mortar. For weight of solid Walls see Table 1, page 9. Table 5, page 26, gives heights by courses.

Sq. Ft. Area of Wall	8-INCH WALL					12-INCH WALL					16-INCH WALL					Sq. Ft. Area of Wall
	No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours: Lime or Cement-Lime Mortar	Bricklayer's Approx. Time Hours: Cement Mortar	No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours: Lime or Cement-Lime Mortar	Bricklayer's Approx. Time Hours: Cement Mortar	No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours: Lime or Cement-Lime Mortar	Bricklayer's Approx. Time Hours: Cement Mortar	
1	12.705	.135	.093	.084	.092	19.251	.194	.139	.128	.140	25.796	.254	.186	.137	.172	1
10	128	1½	1	1	1	193	2	1½	1½	1½	258	3	2	1½	2	10
20	255	3	2	2	2	386	4	3	2½	3	516	5½	4	3	3½	20
30	382	4½	3	2½	3	578	6	4½	4	4	774	8	5½	4	5	30
40	509	5½	4	3½	4	771	8	5½	5½	5½	1032	10	8	5½	7	40
50	636	7	5	4	5	963	10	7	6½	7	1290	13	9	7	8½	50
60	763	8½	5½	5	5½	1156	12	9	8	8½	1548	16	11	8	10½	60
70	890	9½	6½	6	6½	1348	14	10	9	10	1806	18	13	9½	12	70
80	1,017	11	8	7	7½	1541	16	11	10½	11	2064	21	15	11	14	80
90	1,144	12	8½	7½	8	1733	18	13	12	12½	2322	23	17	12½	15½	90
100	1,271	14	9	8½	9	1926	20	14	13	14	2580	26	19	14	17	100
200	2,542	27	19	17	19	3851	39	28	26	28	5160	51	37	27	34	200
300	3,812	41	28	25	28	5776	42	42	38½	42	7740	77	56	41	52	300
400	5,083	54	37	34	37	7701	78	56	52	56	10,319	102	75	55	69	400
500	6,353	68	46	42	46	9626	98	70	64	70	12,899	127	93	69	86	500
600	7,624	81	56	50	56	11,551	117	84	77	84	15,479	153	112	82	103	600
700	8,895	95	65	59	65	13,476	137	98	90	98	18,058	178	131	96	120	700
800	10,165	108	74	67	74	15,402	156	112	102	112	20,638	204	149	110	138	800
900	11,436	122	84	76	83	17,327	176	126	115	126	23,218	229	168	123	155	900
1 000	12,706	135	93	84	93	19,252	195	140	128	140	25,797	255	187	137	172	1.000
2,000	25,412	270	185	168	185	38,503	399	279	256	280	51,594	509	373	274	344	2,000
3 000	38,118	406	278	252	277	57,754	585	419	384	420	77,391	764	560	411	516	3,000
4 000	50,824	541	371	336	370	77,006	779	558	512	560	103,188	1018	746	548	688	4,000
5.000	63,530	676	463	420	462	96,257	974	698	640	700	128,984	1272	933	685	860	5,000
6.000	76,236	811	556	504	555	115,508	1169	838	768	840	154,781	1527	1119	822	1032	6,000
7.000	88,942	946	648	588	647	134,760	1364	977	896	980	180,578	1781	1306	959	1204	7,000
8 000	101,648	1081	741	672	739	154,011	1558	1117	1024	1120	206,375	2036	1492	1096	1376	8,000
9.000	114,353	1216	834	756	832	173,262	1753	1256	1152	1260	232,172	2290	1679	1233	1548	9,000
10.000	127,059	1351	926	840	924	192,514	1948	1396	1280	1400	257,968	2545	1865	1370	1720	10,000

TABLE 27—Solid Exterior walls in Flemish, English, and English Cross Bonds, ½″ joints. Materials and labor for square foot areas. Brick in outside 8″ thickness laid ½″ joints, with as many vertical joints parallel to the length of the wall left open as possible. Remaining brick in thicker walls laid on full mortar bed, but with brick touching end to end, and vertical space between each 4″ thickness left open. Laborer's time includes mortar making. See table 29 for material needed for cubic feet of mortar. For weight of solid walls see Table 1, page 9. For number of facing bricks see Tables 19 and 20, page 68. For table of heights by courses see Table 5, page 26.

Sq. Ft. Area of Wall	8-INCH WALL					12-INCH WALL					16-INCH WALL					Sq. Ft. Area of Wall
	No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time, Hours	Bricklayer's Approx. Time Hours: Lime or Cement-lime Mortar	Bricklayer's Approx. Time Hours: Cement Mortar	No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time, Hours	Bricklayer's Approx. Time Hours: Lime or Cement-lime Mortar	Bricklayer's Approx. Time Hours: Cement Mortar	No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time, Hours	Bricklayer's Approx. Time Hours: Lime or Cement-lime Mortar	Bricklayer's Approx. Time Hours: Cement Mortar	
1	12.320	.195	.095	104	109	18.866	.254	.141	.158	.167	25.411	.313	.188	.179	.197	1
10	124	2	1	1	1	189	3	1½	1½	2	255	3½	2	2	2	10
20	247	4	2	2	2½	378	5½	3	3½	3½	509	6½	4	3½	4	20
30	370	6	3	3½	3½	566	8	4½	5	5	763	9½	6	5½	6	30
40	493	8	4	4½	4½	755	10½	6	6½	7	1017	13	8	7½	8	40
50	617	10	5	5½	5½	944	13	7	8	8½	1271	16	10	9	10	50
60	740	12	6	6½	6½	1132	16	9	10	10	1525	19	11	11	12	60
70	863	14	7	7½	8	1321	18	10	11	12	1779	22	13	13	14	70
80	986	16	7½	8½	9	1510	21	12	13	14	2033	25	15	15	16	80
90	1109	18	9	10	10	1698	23	13	14	15	2288	29	17	17	18	90
100	1233	20	10	11	11	1887	26	14	16	17	2542	32	19	18	20	100
200	2465	39	19	21	22	3774	51	28	32	34	5083	63	38	36	39	200
300	3697	59	29	31	33	5660	77	43	48	51	7624	94	57	54	59	300
400	4929	78	38	42	44	7547	102	57	64	67	10,165	126	76	72	79	400
500	6161	98	47	52	55	9434	127	71	80	84	12,706	157	94	90	99	500
600	7393	117	57	62	66	11,320	153	85	96	101	15,248	189	113	108	118	600
700	8625	137	66	73	77	13,207	178	99	111	118	17,789	220	132	126	138	700
800	9857	156	76	83	88	15,094	204	113	127	134	20,330	251	151	144	158	800
900	11,089	175	85	94	99	16,980	229	128	143	151	22,871	283	170	161	177	900
1000	12,321	195	95	104	110	18,867	255	142	159	168	25,412	314	189	179	197	1000
2000	24,642	390	189	208	219	37,733	509	283	318	336	50,824	628	377	359	394	2000
3000	36,963	584	284	311	329	56,599	763	425	477	503	76,236	942	565	538	591	3000
4000	49,284	779	378	415	438	75,466	1017	566	636	671	101,648	1256	754	717	788	4000
5000	61,605	973	473	519	548	94,332	1272	708	795	839	127,059	1570	942	896	955	5000
6000	73,926	1168	567	623	757	113,198	1526	849	953	1006	152,471	1884	1131	1075	1182	6000
7000	86,247	1363	662	726	767	132,065	1780	990	1112	1174	177,883	2198	1319	1255	1379	7000
8000	98,567	1557	756	830	876	150,931	2035	1132	1271	1342	203,295	2512	1508	1434	1576	8000
9000	110,888	1752	851	934	986	169,797	2289	1273	1430	1510	228,706	2826	1696	1613	1773	9000
10000	123,209	1947	945	1038	1095	188,664	2543	1415	1589	1677	154,118	3140	1885	1790	1970	10000

TABLE 28—Solid Walls in all bonds with ½″ joints, all joints filled with mortar. Materials and labor for square foot areas. "Other bonds" includes Flemish, English, and English Cross bonds. Laborer's time includes mortar making. See Table 29 for material needed for cubic feet of mortar. For weight of solid walls see Table 1, page 9, Table 5, page 26, gives heights by courses.

Sq. Ft. Area of Wall	4-INCH WALL				8-INCH WALL							12-INCH WALL							16-INCH WALL							Sq. Ft. Area of Wall
								Bricklayer's Approx. Time, Hours							Bricklayer's Approx. Time, Hours							Bricklayer's Approx. Time, Hours				
								Common Bond		Other Bonds					Common Bond		Other Bonds					Common Bond		Other Bonds		
	No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Lime or Cement-lime Mortar	Cement Mortar	Lime or Cement-lime Mortar	Cement Mortar	No. of Bricks	Cu ft of Mortar	Laborer's Approx. Time Hours	Lime or Cement-Lime Mortar	Cement Mortar	Lime or Cement-lime Mortar	Cement Mortar	No of Bricks	Cu. ft of Mortar	Laborer's Approx. Time Hours	Lime or Cement-lime Mortar	Cement Mortar	Lime or Cement-lime Mortar	Cement Mortar	
1	6.160	.075	.045	.062	12.320	.195	.095	.090	.099	104	.109	18.481	.314	.143	.134	.148	.156	.164	24.641	.433	.192	.152	.179	.179	.197	1
10	62	1	½	¾	124	2	1	1	1	1	1	185	3½	1½	1½	1½	½	2	247	4½	2	1½	2	2	2	10
20	124	2	1	1½	247	4	2	2	2	2	2½	370	6½	3	3	3	3½	3½	493	9	4	3	3½	3½	4	20
30	185	2½	1½	2	370	6	3	3	3	3½	3½	555	9½	4½	4	4½	5	5	740	13	6	4½	5½	5½	6	30
40	247	3½	2	2½	493	8	4	3½	4	4½	4½	740	13	6	5½	6	6½	6½	986	17½	8	6	7½	7½	8	50
50	309	4	2½	3½	617	10	5	4½	5	5½	5½	925	16	7½	7	7½	8	8½	1,233	22	10	8	9	9	10	50
60	370	5	3	4	740	12	6	5½	6	6½	6½	1,109	19	9	8	9	9	10	1,479	26	12	9	11	11	12	60
70	432	5½	3½	4½	863	14	7	6½	7	7½	8	1,294	22	10	10	11	11	12	1,725	31	14	11	13	13	14	70
80	493	6½	4	5	986	16	7½	7½	8	8½	9	1,479	25	12	11	12	13	13	1,972	35	16	12	15	15	16	80
90	555	7	4½	5½	1,109	18	9	8	9	10	10	1,664	28	13	12	13	14	15	2,218	39	17	14	17	17	18	90
100	617	8	5	6½	1,233	20	10	9	10	11	11	1,849	32	15	14	15	16	17	2,465	44	19	15	18	18	20	100
200	1,233	15	9	13	2,465	39	19	18	20	21	22	3,697	63	29	27	30	31	33	4,929	87	39	30	36	36	39	200
300	1,849	23	14	19	3,697	59	29	27	30	31	33	5,545	94	43	41	45	47	49	7,393	130	58	46	54	54	59	300
400	2,465	30	18	25	4,929	78	38	36	40	42	44	7,393	126	58	54	59	62	66	9,857	173	77	61	72	72	79	400
500	3,081	38	23	31	6,161	98	47	45	49	52	55	9,241	157	72	67	74	78	82	12,321	217	96	76	90	90	99	500
600	3,697	46	28	37	7,393	117	57	54	59	62	66	11,089	189	86	81	89	94	99	14,786	260	116	91	108	108	118	600
700	4,313	53	32	43	8,625	137	66	69	69	73	77	12,937	220	101	94	104	109	115	17,250	303	135	106	125	125	138	700
800	4,929	61	37	49	9,857	156	76	72	79	83	88	14,786	251	115	108	118	124	131	19,714	347	154	122	143	143	158	800
900	5,545	68	41	56	11,089	175	85	81	89	94	99	16,634	283	129	121	133	140	148	22,178	390	173	137	161	161	177	900
1,000	6,161	76	46	62	12,321	195	95	90	99	104	110	18,482	314	144	135	148	156	164	24,642	433	192	152	179	179	197	1,000
2,000	12,321	151	91	123	24,642	390	189	179	197	208	219	36,963	628	287	269	296	311	328	49,284	866	385	304	359	359	394	2,000
3,000	18,482	227	137	185	36,963	584	284	269	296	311	329	55,444	942	430	403	444	467	492	73,926	1299	577	451	538	538	591	3,000
4,000	24,642	302	183	247	49,284	779	378	359	394	415	438	73,926	1255	574	538	592	623	657	98,567	1732	769	608	717	717	788	4,000
5,000	30,803	377	228	308	61,605	973	473	448	493	519	548	92,407	1569	717	672	739	778	721	123,209	2165	961	760	896	896	985	5,000
6,000	36,963	453	274	370	73,926	1168	567	538	592	623	657	110,888	1883	860	807	887	934	985	147,851	2599	1154	912	1075	1075	1182	6,000
7,000	43,124	528	320	431	86,247	1363	662	627	690	726	767	129,370	2197	1004	941	1035	1090	1149	172,493	3032	1346	1064	1255	1255	1379	7,000
8,000	49,284	604	365	493	98,567	1557	756	717	789	830	876	147,851	2511	1147	1075	1183	1245	1313	197,124	3465	1538	1216	1434	1434	1576	8,000
9,000	55,444	679	411	555	110,888	1752	851	807	887	934	986	166,332	2825	1291	1210	1331	1401	1478	221,776	3898	1730	1368	1613	1613	1773	9,000
10,000	61,605	755	457	616	123,209	1947	945	896	986	1038	1095	184,813	3139	1434	1344	1479	1557	1643	246,418	4331	1923	1520	1792	1792	1970	10,000

TABLE 29—Quantities of Material for Cubic Feet of Mortar Found in Other Tables. Quantities of lime are based on the use of good quality lime. Lime quantities are approximate and will vary with the grade of lime and the size of particles composing the sand. In the cement mortars 1/10 of the cement by weight is replaced by dry hydrated lime or its equivalent in lump lime paste.

Cu. Ft. Mortar	LIME MORTAR 1:2½ 180 lb. Bbls. Lump Lime	or	50 lb. Sacks Hydrated Lime	Cu. Yds. Sand	LIME MORTAR 1:3 180 lb. Bbls. Lump Lime	or	50 lb. Sacks Hydrated Lime	Cu. Yds. Sand	CEMENT-LIME MORTAR 1:1:6 94 lbs. Net Sacks Cement	180 lb. Bbls. Lump Lime	or	50 lb. Sacks Hydrated Lime	Cu. Yds. Sand	CEMENT MORTAR 1:2 94 lb. Net Sacks Cement	180 lb. Bbls. Lump Lime	or	50 lb. Sacks Hydrated Lime	Cu. Yds. Sand	CEMENT MORTAR 1:3 94 lb. Net Sacks Cement	180 lb. Bbls. Lump Lime	or	50 lb. Sacks Hydrated Lime	Cu. Yds. Sand	CEMENT MORTAR 1:4 94 lb. Net Sacks Cement	180 lb. Bbls. Lump Lime	or	50 lb. Sacks Hydrated Lime	Cu. Yds. Sand	Cu. Ft. Mortar
1	.057	or	.350	.037	.1	or	.3	037	.129	.023	or	.145	037	4	.1	or	1	1	.3	.1	or	.1	1	.3	.1	or	.1	.1	1
2	.1	or	.7	1	.1	or	.6	.1	.3	.1	or	.3	1	9	.1	or	2	1	7	.1	or	.1	1	.5	.1	or	.1	.1	2
3	.2	or	1.1	1	.1	or	.9	.1	.4	.1	or	.4	1	1 3	1	or	.3	1	1 0	.1	or	.2	1	.8	.1	or	.2	.1	3
4	.2	or	1.4	1	.2	or	1.2	1	.5	1	or	.6	1	1 8	1	or	.4	1	1.3	.1	or	3	2	1 1	.1	or	2	.2	4
5	.3	or	1.8	2	.2	or	1.5	2	.6	.1	or	.7	2	2 2	1	or	.5	2	1.7	.1	or	3	2	1 3	.1	or	3	.2	5
6	.3	or	2.1	2	.3	or	1.8	2	.8	.1	or	.9	2	2 7	.1	or	6	2	2.0	.1	or	4	2	1.6	.1	or	3	.2	6
7	.4	or	2.5	3	.3	or	2.0	3	.9	.2	or	1.0	3	3 1	.1	or	6	2	2.3	.1	or	5	3	1.8	.1	or	.4	3	7
8	.5	or	2.8	.3	.4	or	2.3	3	1.0	.2	or	1.2	3	3 5	.1	or	.7	3	2.6	.1	or	6	3	2.1	.1	or	4	.3	8
9	.5	or	3.2	.3	.4	or	2.6	.3	1.2	.2	or	1.3	3	3.9	1	or	.8	3	3.0	.1	or	.6	3	2.4	.1	or	.5	.4	9
10	.6	or	3.5	.4	.5	or	2.9	.4	1 3	.2	or	1.5	.4	4 4	2	or	.9	3	3.3	.1	or	7	4	2 6	.1	or	.6	4	10
11	.7	or	3.9	.4	.5	or	3 2	4	1 4	.3	or	1.6	.4	4.9	2	or	1.0	4	3.6	.1	or	.8	4	2 9	.1	or	.6	5	11
12	.7	or	4.2	.4	.6	or	3.5	.4	1 6	.3	or	1 7	.4	5.3	.2	or	1.1	4	4 0	.1	or	.8	5	3.2	.1	or	.7	5	12
13	.7	or	4.6	.5	.6	or	3.8	.5	1 7	.3	or	1 9	.5	5.7	.2	or	1.2	4	4.3	.2	or	9	5	3.4	.1	or	.7	5	13
14	.8	or	4.9	.5	.7	or	4 1	.5	1 8	.3	or	2.0	.5	6.2	.2	or	1.3	5	4.6	.2	or	9	5	3.7	.1	or	.8	6	14
15	.9	or	5.3	.6	.7	or	4 4	.6	1.9	.4	or	2.2	.6	6.6	.2	or	1.4	5	5.0	.2	or	1 0	6	4.0	.2	or	.8	6	15
16	.9	or	5.6	.6	.8	or	4.7	.6	2.1	.4	or	2.3	.6	7.1	3	or	1.5	5	5.3	.2	or	1.1	6	4 2	.2	or	9	7	16
17	1.0	or	6.0	.6	.8	or	5 0	.6	2.2	.4	or	2.5	.6	7 5	3	or	1.6	6	5 6	.2	or	1.2	7	4 6	.2	or	9	7	17
18	1.0	or	6.3	.7	.9	or	5.3	.7	2 3	.4	or	2.6	.7	8 0	3	or	1.7	6	6 0	.2	or	1.2	7	4 8	.2	or	1.0	7	18
19	1.1	or	6.7	.7	.9	or	5 5	7	2.5	.5	or	2.8	.7	8 4	3	or	1.8	6	6 3	.2	or	1.3	.7	5 0	2	or	1.0	8	19
20	1.1	or	7.0	.7	.9	or	5 8	7	2.6	.5	or	2.9	.7	8.9	3	or	1.8	7	6 6	.2	or	1.4	8	5.3	.2	or	1.1	8	20
27	1.5	or	9.5	1.0	1.3	or	7.8	1.	3 50	.64	or	3.94	1.0	12 0	.4	or	2.5	9	8 9	.3	or	1.9	1.1	7 1	3	or	1.5	1 1	27
30	1.7	or	10.5	1.1	1.4	or	8.7	1.1	3.8	7	or	4.4	1 1	13 3	5	or	2.8	1.0	9.9	.4	or	2 1	1.2	7.9	.3	or	1.7	1.2	30
40	2.3	or	14.0	1.5	1.9	or	11.7	1 5	5.2	.9	or	5.8	1 5	17 7	7	or	3.7	1 3	13.2	.5	or	2 8	1 6	10.6	.4	or	2 2	1.6	40
50	2.8	or	17.5	1.9	2.4	or	14.6	1.9	6.5	1.2	or	7.3	1.9	22 1	8	or	4.6	1 7	16.5	6	or	3 5	1.9	13 2	.5	or	2.8	2.1	50
60	3.4	or	21.0	2.2	2.8	or	17.5	2.2	7 8	1.4	or	8.8	2 2	26.6	1 0	or	5.5	2.1	19.8	7	or	4.1	2.3	15 8	.6	or	3.3	2 5	60
70	3.9	or	24.5	2.6	3.3	or	20.4	2.6	9.1	1.7	or	10.2	2 6	31.0	1 1	or	6.5	2.4	23.1	.9	or	4.8	2.7	18 5	7	or	3.9	2.9	70
80	4.6	or	28.0	3.0	3.8	or	23.3	3.0	10 4	1.9	or	11.7	3.0	35 4	1 3	or	7.4	2.8	26.4	2.0	or	5.5	3.1	21.1	8	or	4.4	3.3	80
90	5.1	or	31.5	3.3	4.3	or	26.3	3.3	11.7	2.1	or	13.1	3.3	39.8	1 5	or	8.3	3 1	29.8	1.1	or	6.2	3.5	23 8	.9	or	5.0	3.7	90
100	6	or	35	4	5	or	29	4	13	2	or	15	4	44	2	or	9	3	33	1.2	or	7	4	26	1	or	6	4	100
200	11	or	70	7	9	or	58	7	26	5	or	29	7	88	3	or	18	7	66	2	or	14	8	53	2	or	11	8	200
300	17	or	105	11	14	or	88	11	39	7	or	44	11	132	5	or	28	10	99	4	or	21	12	79	3	or	17	12	300
400	23	or	140	15	19	or	117	15	52	10	or	58	15	177	7	or	37	14	132	5	or	28	16	106	4	or	22	16	400
500	29	or	175	19	24	or	146	19	65	12	or	73	19	221	8	or	46	17	165	6	or	35	19	132	5	or	28	21	500
600	34	or	210	22	28	or	175	22	78	14	or	88	22	265	10	or	55	21	198	7	or	41	23	158	6	or	33	25	600
700	40	or	245	26	33	or	204	26	91	17	or	102	26	310	11	or	65	24	231	9	or	48	27	184	7	or	39	29	700
800	46	or	280	30	38	or	233	30	104	19	or	117	30	354	13	or	74	28	265	10	or	55	31	211	8	or	44	33	800
900	51	or	315	33	43	or	263	33	117	21	or	131	33	398	15	or	83	31	298	11	or	62	35	238	9	or	50	37	900
1000	57	or	350	37	47	or	292	37	130	24	or	146	37	442	16	or	92	34	331	12	or	69	39	264	10	or	55	41	1000
2000	114	or	700	74	95	or	584	74	259	47	or	292	74	885	33	or	185	68	661	24	or	138	78	528	20	or	110	82	2000
3000	171	or	1050	111	142	or	876	111	389	71	or	438	111	1328	49	or	277	103	992	37	or	207	117	792	29	or	165	123	3000
4000	228	or	1400	148	190	or	1167	148	518	95	or	584	148	1771	65	or	370	138	1322	49	or	276	156	1056	39	or	221	164	4000
5000	285	or	1750	185	237	or	1459	185	648	119	or	730	185	2214	82	or	462	172	1654	61	or	345	194	1320	49	or	276	206	5000

TABLE 30—Flues laid with ½" joints. All joints filled with mortar. Material and labor for heights in feet. Laborer's time includes mortar making. See Table 29 for material needed for cubic feet of mortar.
NOTE:—These tables may be used for almost any one and two flue chimneys, as the variations from these figures would be slight, no matter the size of the flues.

Height in Feet	8 x 8 FLUE No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	12 x 12 FLUE No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	12 x 12 and 8 x 12 FLUES No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	8 x 8 FLUE No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	12 x 12 FLUE No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	12 x 12 and 8 x 12 FLUES No. of Bricks	Cu. ft. of Mortar	Laborer's Approx. Time Hours	Bricklayer's Approx. Time Hours	Height in Feet
1	25.873	.433	.200	.344	34.498	.577	.267	.459	53.895	.810	.410	.718	17.249	.288	.133	.229	23.717	.396	.183	.316	36.652	613	.283	.488	1
2	52	1	½	¾	69	1½	½	1	108	2	1	1½	35	1	¼	½	48	1	½	¾	74	1½	½	1	2
3	78	1½	¾	1	104	2	¾	1½	162	2½	4¼	2¼	52	1	½	¾	72	1½	½	1	110	2	¾	1½	3
4	104	2	¾	1½	138	2½	1	1¾	216	3½	1¾	3	69	1½	½	1	95	2	¾	1¼	147	2½	1¼	2	4
5	130	2½	1	1¾	173	3	1¼	2¼	270	4½	2	3½	87	1½	¾	1¼	119	2	1	1½	184	3½	1½	2½	5
6	156	3	1¼	2	207	3½	1½	2¾	324	5	2½	4¼	104	2	¾	1½	143	2½	1	1	220	4	1¾	3	6
7	182	3½	1½	2½	242	4½	1¾	3¼	378	6	3	5	121	2½	1	1½	166	3	1¼	2¼	257	4½	2	3½	7
8	207	3½	1½	2¾	276	5	2¼	3¾	432	6½	3¼	5¾	138	2½	1	1¾	190	3½	1½	2½	294	5	2¼	4	8
9	233	4	1¾	3	311	5½	2½	4¼	486	7½	3½	6½	156	3	1¼	2	214	4	1¾	3	330	6	2½	4½	9
10	259	4½	2	3½	345	6	2¾	4½	539	8½	4	7¼	173	3	1½	2¼	238	4	1¾	3¼	367	6½	2¾	5	10
15	389	6½	3	5¼	552	9	4	7	809	12½	6	10¾	259	4½	2	3½	356	6	2¾	4¾	550	9½	4¼	7¼	15
20	518	9	4	7	690	12	5½	9¼	1078	16½	8	15	345	6	2¾	4½	475	8	3¾	6¼	734	12½	5¾	9¾	20
25	647	11	5	8½	863	14½	6¾	11½	1348	21	10	18	432	7½	3½	6	593	10	4½	8	917	15½	7	12¼	25

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